Route to:

Return to:

INSTITUTE OF GAS TECHNOLOGY

THE GAS INDUSTRY'S OWN EDUCATIONAL AND RESEARCH FACILITY

CHICAGO 16, ILLINOIS

GAS ABSTRACTS

JANUARY, 1961

VOLUME 17 NUMBER 1

AFFILIATED WITH

ILLINOIS INSTITUTE OF TECHNOLOGY

CONTENTS

1. **Management**—Gas industry progress, business problems, statistics, government regulation, safety, personnel, education..... 1

2. **Energy Supply and Economics**—Resources, reserves, and competitive applications of the fossil fuels and other sources of energy, including nuclear and solar energy..... 5

3. **Natural Gas and Petroleum Production**—Geology, exploration, drilling, well management, reservoir engineering..... 7

4. **Gas Conditioning and LPG Recovery**—Condensate, dust, CO_2 and sulfur removal, dehydration, odorization, oil fogging, humidification; LPG recovery and refining..... 9

5. **Natural Gas Transmission**—Pipelines, compressors, dispatching, flow regulation, communications, maintenance..... 9

6. **Gas and LPG Storage**—Holders, pressure tanks, underground storage; liquefaction, refrigerated storage..... 11

7. **Manufactured Gas and Chemical Processing**—Gasification of coal, oil; reformed gas; chemical treatment; byproducts; synthesis gas production and conversion; petrochemicals; catalysts, catalyst development..... 11

8. **Gas Distribution**—City utility systems: design, operation, maintenance; weather influence on peak loads and supply; LPG-air mixtures..... 14

9. **Gas Fuel Utilization and Appliances**—Domestic, commercial, industrial; burners; combustion research; air pollution..... 15

10. **Equipment and Instrumentation**—Production and handling equipment, and maintenance; computers; controls; measurement..... 18

11. **Materials of Construction, and Corrosion**—Metals, refractories, plastics; corrosion measurement, prevention..... 20

12. **Analytical Methods and Tests**—Standard and research techniques for gas-making materials, products, processes; instrumental analysis..... 21

13. **Basic Science**—Chemistry, physics and basic engineering related to gas technology; physical properties of gases: phase equilibria, thermodynamics, reaction kinetics, heat and mass transfer, fluid flow..... 22

Services Available to Readers—Photocopies, microfilm, Russian translations, bibliographies and literature searches, *Gas Abstracts on Cards*, back numbers of *Gas Abstracts*.....**Inside Back Cover**

Publications Abstracted for Gas Abstracts.....**Back Cover**

O. P. BRYSCH, Editor — P. J. CHATTA, Assistant Editor

GAS ABSTRACTS is published and distributed monthly by the Institute of Gas Technology, Chicago 16, Illinois. The contents of selected papers and patents are reviewed impartially by the editorial staff and material of potential interest to the Gas Industry is presented.

Subscription rates to nonmembers of the Institute: $18.00 per year to U. S. addresses; $22.00 foreign. Regardless of the month in which it is entered, each subscription starts with the January issue. A gold-stamped fabrikoid binder for the year, and title- and end-pages for that volume, are sent with the January issue. A complete index to the year's issues is mailed as soon after the year's end as it can be prepared, edited and printed.

Copyright 1961 by the Institute of Gas Technology. Printed in the U.S.A.

A microfilm edition of Gas Abstracts can be supplied by University Microfilms, 313 N. First St., Ann Arbor, Michigan.

1. MANAGEMENT

Natural Gas

Gas Users Served Best by No Rate Regulation. O. E. Zwanzig. *Can. Gas. J. 53,* 28 (1960) Nov. (5 pp.)

Time may be at hand, says author, for the elimination or substantial revision, and/or relaxation of price regulation of natural gas sales—wellhead, city gate and ultimate consumer sales. Such an apparently drastic reorientation of regulatory philosophy can well be in the consumer and public interest. Purpose of article is to indicate how elimination, relaxation or drastic modification of natural gas price regulation may well serve consumer and public interest. Argument is restricted to price regulation and is not a plea to eliminate all regulation.

Natural Gas—The Pipeline Industry. B. D. Goodrich. *Mech. Eng. 83,* 26 (1961) Jan. (5 pp.)

Chronological review of the growth of the natural gas pipeline industry, its effect on spurring the growth of the natural gas industry, technological advances, economic impact and a projection of its future role.

What's Ahead in Natural Gas Processing in Canada. J. G. Stabback. *Petro/Chem 33,* C-24 (1961) Jan. (5 pp.)

Canada's gas processing industry should double in invested capital for new plants and equipment in the next decade. Plant investments should total $260,000,000 for Alberta alone and as much as $340,000,000 for Western Canada as a whole. Current operations are located in Alberta, Saskatchewan and British Columbia, and future developments probably will be constructed in the Yukon and Northwest Territories. Total installed plant capacity to date is approximately 1930 MMCF/day, residue gas basis, corresponding to an estimated investment of some $160,000,000. Author lists Canadian natural gas processing plants in operation before the end of 1960.

Gas Industry Expansion

Gas Industry Sees 1961 Business Topping Records Set During 1960. L. T. Potter. *A.G.A. Public Inf. Bur. Release 58A-N60,* 1 (1960) Dec. 29 (12 pp.)

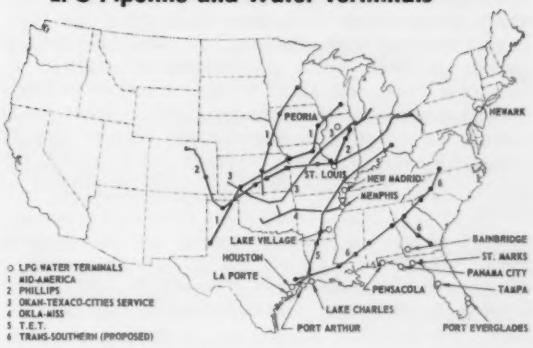
A.G.A. president reports that gas utility and pipeline industry set new highs in all areas of activity during 1960, and expects to do even more business and experience greater growth in 1961. Gas industry sales in 1960 climbed 12 per cent, to a total of nearly $5.7 billion—and it is expected that they will pass the $6 billion-mark in 1961. Reserves reached 262.6 trillion CF at the beginning of 1960. New reserves discovered in 1959—nearly 6 trillion CF—were the third highest on record, exceeded only by discoveries in 1957 and 1953.

Gas Industry Management

Computer + Modern Business Forms = Streamlined Paperwork. F. A. Langenfeld. *Gas 37,* 97 (1961) Jan. (4 pp.)

Description of integrated data-processing system at Northern Natural Gas (Omaha, Neb.) Applications and benefits are discussed.

LPG Pipeline and Water Terminals



(Adapted from *LP-Gas Brought . . .* See abstract p. 6)

Air Pollution

An Inspection Method for Automobile Hydrocarbon Emission. R. L. Chapman. *J. Air Pollution Control Assoc. 10,* 463 (1960) Dec. (2 pp.)

In June 1959, the governor of California took the first step toward the formulation of unprecedented legislation to control the emission of specific air contaminants from motor vehicle exhaust. Years of endeavor by scientists and public officials preceded this act, but in order to implement it, much more work lay ahead. Not the least of this involved the development of practical, simple methods for the analysis of auto exhaust, that may be used by the law enforcing agencies. At the present time legislators are very close to being able to draft logical, effective standards to control automobile-generated smog. Physical means of controlling the emission of smog are in existence, and the means of inspecting these control devices are available.

Appliances

You Won't Recognize the Gas Appliances of Tomorrow. T. L. Robey. *Butane-Propane News 23,* 33 (1961) Jan. (3 pp.)

Currently in the field of domestic utilization research, A.G.A. is sponsoring work on flexible appliance connectors, new range top burners and ignition systems, disappearing high-speed oven broilers, space saving over/under built-in oven and non-integral water heater combinations as well as significant advances in ignition technology. Author includes a baseboard gas heater and flameless cooking units in his discussion of the all-gas house of tomorrow.

Aromatics

Petrochemicals. Part 5. Oil-Based Aromatics Gain First Place. R. F. Messing and J. W. Bradley. *Chem. Eng. 67,* 50 (1960) Dec. 26 (6 pp.)

Starting from petroleum benzene's present capacity of about 305 million gallons, about 194 million is either under construction or planned, representing about a 64 per cent increase in capacity. The availability of toluene from both petroleum and coal tar sources amounts to about 340 million gallons. The end-use distribution re-

flects the relatively limited uses for toluene. About two-thirds of the output is returned to gasoline as a high-octane blending stock. Fuel markets, about 106 million gallons in 1959, again predominate for xylene, although solvents, with about 64 million gallons in 1959, take about one-quarter of the total 242.5-million gallon output. Contribution to naphthalene capacity that is planned by the petroleum operators almost equals the amount that was recovered from coal tar sources in 1959.

Communications

Effective Technical Reporting. Put Life in Your Report Writing. K. O'Keeffe. *Petrol. Refiner 39,* 109 (1960) Dec. (7 pp.)

Introductory article in special report points out that to write clearly, concisely and convincingly is a skill, not an art. This ability, says author, can be developed by practicing the principles of good writing. Once mastered, they are easily, even automatically, applied.

Effective Technical Reporting. How to Sell Your Ideas Orally. R. Atwood. *Petrol. Refiner 39,* 126 (1960) Dec. (3 pp.)

Before a person learns to lead, he must learn to follow. The same reasoning applies to oral report presentation. Before he can learn to speak, a person must learn to listen. Thoughts must be projected before they are verbalized—organized before they become words. By doing this, a person listens to what he says before he says it. This simple mental discipline can prevent a semantic barrier between speaker and listener.

Effective Technical Reporting. Supplements to the Technical Report. J. Walter. *Petrol. Refiner 39,* 116 (1960) Dec. (5 pp.)

There is more to an effective technical report than the body or comprehensive part. Supplementary parts include: title, foreword, table of contents (in outline form), abstract, and introduction. Author tells how to make these meaningful.

Effective Technical Reporting. You Be the Editor. C. H. Vervalin. *Petrol. Refiner 39,* 121 (1960) Dec. (5 pp.)

Poor sentence structure results in a dull, lifeless report. Author outlines simple rules which, if followed, can be used to add clarity that will win reader interest and improve comprehension. Exercises in wordage reduction are included.

Construction Costs

Industrial Construction Costs in Latin America. E. A. Arroyave. *Cost Eng. 5,* 16 (1960) Oct. (4 pp.)

Problem of economic equipment, materials and construction methods selection in Latin America is complicated by the varied and changing tariffs between countries. This makes it difficult to determine the Latin American delivered cost of equipment purchased from other parts of the world. However, tabulated data in article are sufficiently accurate to enable one to estimate the cost factors for transportation and delivery of equipment to Venezuela.

Costs

Estimating Plant Investment Costs. J. H. Hirsch and E. M. Glazier. *Chem. Eng. Progress 56,* 37 (1960) Dec. (7 pp.)

Material, heat, and economic balances are intimately interlinked, and it is only by treating them as such at each stage of progress, from research to commercialization, that optimum results can be obtained. Under this concept, the cost data book should occupy a place beside the technical data books. In the former no section is more important than that dealing with the estimating of plant investment costs for new processes. It is to this phase of the work that article is devoted—particularly to the handling of processes at the development-engineering stage, when research is still in progress and where considerable technical and economic guidance are required.

Off-Site Investment and Working Capital. S. P. Dickens and F. R. Douglas. *Chem Eng. Progress 56,* 44 (1960) Dec. (9 pp.)

Methods of estimating off-site investment and working capital are presented. These costs, often very large, should be a vital part of most profitability analyses, say authors. The use of percentage factors is recommended for quick order-of-magnitude estimates of off-site costs; specific factors to be used depend largely on whether the process considered is an addition to an existing or new plant. Costs of individual off-site facilities are presented for the purpose of arriving at more accurate estimates. Factors to be considered for working capital estimation are suggested; also, a typical cash flow analysis of working capital is given.

Drilling

1961 — Forecast and Trends for Air/Gas Drilling. R. W. Sneed. *Petrol. Eng. 33* (Drilling and Producing), B-34 (1961) Jan. (3 pp.)

Spectacular growth of air/gas drilling cannot be reasonably predicted for the United States and Canada during 1961. However, the consistent expansion of gaseous circulating media into drilling and production applications will not slacken. Certain trends in the industry will bolster utilization of air/gas drilling technology, reinforced by advances in the technology itself.

Trends in Drilling Costs: Today and Tomorrow. O. E. Mechem. *Petrol. Eng. 33* (Drilling and Producing), B-19 (1961) Jan. (3 pp.)

Good business management in all segments will play an increasing role, says author. Better well programming, faster application of technological advances and closer cooperation between contractors and operator are seen as contributing factors to further cost reduction.

Exploration

France Moves to Diversify Sahara Crude Oil Markets. *World Oil 152,* 83 (1961) Jan. (2 pp.)

French government is trying a new approach to insure diversification of markets for Sahara crude throughout West Europe. The latest group of Sahara exploration

permits is expected to attract investment from several private Italian and West German companies for the first time. The French interests were granted almost three-fifths of the new concessions of 8164 square miles which represented 59.8 per cent of the total awards. However, non-French interests were awarded 5477 square miles, representing the remainder of the new concessions granted.

Management Thinking Changes in California. M. R. Rector. *Oil Gas J. 58,* 197 (1960) Dec. 26 (3 pp.)

Results of new approach to exploration in the Sacramento Valley have shown in the discovery of several new gasfields. Beehive Bend-Willows, Perkins Lake, and Comptons Landing with the gas reserves estimated to exceed 324,000 MMCF were discovered and developed during the 1953-55 period. Although the producing sands were found at depths ranging from just below 2000 to nearly 7000 feet, the most prolific producing reservoirs were penetrated, at Beehive Bend-Willows gasfield, below 6000 feet.

Why Explore in California's Sacramento Valley? E. F. Reid. *Oil Gas J. 58,* 74 (1960) Dec. (4 pp.)

During the first three quarters of 1960, 123 exploratory wells and 40 development wells were drilled in the Sacramento Valley. This level of activity in the area is the highest on record, and is the result of a combination of incentives that promises to induce an even greater drilling pace. Purpose of article is to examine these incentives, which may be classified in the general categories of geology, economics and politics.

South Louisiana Seesaw: Discoveries Go Up, Completions Fall. *Oil Gas J. 59,* 48 (1961) Jan. 2 (2 pp.)

Louisiana's rich coastal belt paid off with 42 new oil and gasfields last year, six more than in 1959. Several other 1960 discoveries, now set up as long extensions, may turn out as separate fields. And at least a half-dozen other new fields can be credited to last year's wildcatting.

Foreign Activities

French Pipeliners Put the Finishing Touches on Two More Sahara Lines. *Pipe Line Ind. 13,* 30 (1960) Dec. (4 pp.)

Soon there will be two 24-in. crude lines and one 24-in. gas line bringing hydrocarbons to the Mediterranean coast. The gas line which taps the Hassi R'Mel field, estimated to have a 70-trillion CF reserve, will have the greatest impact on pipelining. Because of the size of the field, with reserves over one-fourth as large as all the reserves of the U. S., the gas must someway be transported to the continent of Europe.

Libya to Date: More Problems Than Oil. P. Swain. *Oil Gas J. 59,* 61 (1961) Jan. 2 (3 pp.)

In 1956 oil exploration began in Libya. The 19 companies now operating there have poured about $370 million into the country. The heady influx of capital in large amounts has had mixed blessings for Libya. Officials, like those in all newly independent nations over the world, are highly nationalistic. Most have only a limited understanding of how the oil industry operates. As longtime colonials, Libyans are inclined to regard the things foreigners do with a certain amount of distrust. An enlightened government would make petroleum prospects even brighter than they are now.

Helium

Helium . . . Its Increased Use and Importance. P. V. Mullins. *Gas 37,* 57 (1961) Jan. (6 pp.)

Rapid and sustained increase in helium consumption has prompted a critical review of the nation's helium resources. Over 75 per cent of the helium produced is consumed by federal agencies, principally defense agencies and the Atomic Energy Commission. After discussing usefulness of helium (derived from its unique physical properties) and production process, author cites reasons for a conservation program. He points out that prospects for new discoveries of major helium sources in the United States are not bright, and that there are few occurrences of helium in foreign countries. It is impossible to predict what new uses may be found for helium in the future, but it is reasonable to predict from present uses and from the general trend of new uses that a helium shortage could handicap the nation seriously in the maintenance of national defense and in the pursuit of technological developments and improvements.

"Noble Gas" Is New Target for 1961. F. J. Gardner. *Oil Gas J. 58,* 195 (1960) Dec. 26.

Until recently, U. S. helium production has been confined to a few areas; now it is expected that plants will rise at several other known helium hideaways, including the richest deposit yet found at Pinta dome, Apache County, Arizona. Helium does not occur as helium *per se,* but as a minor constituent of natural gases; at Pinta, the helium percentage is 8 to 9 compared to an average 2 per cent in the Panhandle fields. Pinta gas is found at a shallow 780-1200 feet in sands of Chinle-Triassic and Coconino-Permian age. Reserve estimates vary with the estimator: Kerr-McKee says 7½ billion CF of recoverable gross gas containing 0.6 billion CF of pure helium; Eastern pegs the field at 22.5 billion gross gas, and 1.8 billion net helium.

Petrochemicals

Big Petrochemical Center Takes Shape. D. H. Stormont. *Oil Gas J. 58,* 54 (1960) Dec. 19 (2 pp.)

Within the past twelve months a half-dozen petrochemical plants have been announced or started along the Delaware River near Philadelphia. Compared with the Houston ship channel area, the Delaware Valley petrochemical industry is little more than an infant. So far, only about $175 million has been invested in plants producing basic and intermediate petrochemicals. The 30-mile region extending from Philadelphia to Wilmington, Del., offers several lures for new chemical plants: plentiful raw materials; abundant fresh water; large labor pool; proximity to markets; and excellent facilities.

Petrochemicals in Canada. J. L. Porter. *Petro/Chem 33,* C-19 (1961) Jan. (5 pp.)

Canada first produced petrochemical ammonia in 1941. As a part of the war effort, a synthetic rubber plant was

completed in the early 1940's. Polyethylene was not produced in Canada before 1953, petroleum benzene before 1958. In all of these, Canadian production lagged that of the United States. A major exception was the conversion of benzene to phenol via the cumene process when the world's first unit was put on stream in 1953 in Montreal. Author reviews petrochemical situation in Canada today.

Petrochemicals in Latin America. R. J. Cameron. *Petro/Chem 33,* C-35 (1961) Jan. (3 pp.)

Until recently, the three largest Latin American nations —Mexico, Brazil and Argentina—have been preoccupied with the production and refining of crude oil. However, existing or currently planned petrochemical facilities already represent substantial capital investments. Future indicates continuous growth of petroleum refining facilities and a petrochemical industry as an economic use for available raw materials and as a stimulus for balanced economic growth. Author reviews general economic situation, petrochemical raw materials, potential demand, and investment possibilities.

U.S. Petrochemicals to Continue Rapid Growth. E. R. Boedeker. *Petro/Chem Eng. 33,* C-8 (1961) Jan. (5 pp.)

Petrochemical industry's contribution to total output of U.S. chemical industry is illustrated: aliphatic segment—petrochemicals accounted for 73 per cent of output volume in 1950 and approximately 86 per cent in 1959; aromatic chemicals—petrochemicals portion of output volume was 28 per cent in 1950, 67-68 per cent in 1959. Output in petrochemical-derived inorganics (ammonia, carbon black and sulfur) has increased from 3.4 billion lb in 1950 to about 13 billion lb in 1959. Thus, in the period 1950-59, production of aliphatics and aromatics has increased 120 per cent, that of petrochemical-derived aliphatics and aromatics 180 per cent. Dollar sales of chemical and allied industries for the same period have increased 56 per cent.

Pipeline Construction

1960 Saw Some Real Advances in Pipe Laying. P. Reed. *Oil Gas J. 59,* 74 (1961) Jan. 2 (3 pp.)

Efforts to get more daily footage from pipeline spreads have been pushed in two directions in the past year. Two different techniques are progressing, each with possibilities of increasing spread output by about 30 per cent under favorable conditions: 1) for small-diameter pipe, a two-pipe-gang method has been demonstrating its value; 2) for large-diameter pipe, double jointing has been increasing steadily with promise of greater use in 1961. Article deals with some details of other practices in addition to the two mentioned.

Enchilada Inch Unfolds. *Gas 37,* 122 (1961) Jan. (2 pp.)

California Gas Transmission Co. (a West Coast-based unit of Tennessee Gas Transmission Co.) and Southern California Edison Co. (a Los Angeles area electric utility) filed applications before California's Public Utilities Commission to import gas through Mexico for exclusive use in Edison's thermoelectric plants. These utilities have made companion filings to construct and operate the Mexico-to-Los Angeles Basin segment of the Texas-Mexico-California natural gas pipeline. Opposition to the filings (see following article) is expected to be aired before the California PUC soon.

SoCal Utilities Vow to Take Pepper Out of Enchilada Inch. *Gas 37,* 74 (1961) Jan. (2 pp.)

Southern Counties and Southern California Gas Companies (both Los Angeles) are preparing to fight the applications (see previous article) on the basis of deficiency of public interest. F. M. Banks, president of SoCal, spoke for both companies: "Under our present public utility method of operation, the needs of all gas users—large and small—are pooled together on an equitable price and supply basis. This pooling of supplies and facilities results in low prices to all." But if a few large industrial customers are allowed to engage in a private deal which reduces this volume, it will leave the small users to pay the entire costs. Plans are to oppose the applications in formal hearings before the California Public Utilities Commission, as well as the Federal Power Commission, should the proposal come under the scrutiny of that body.

Piping

Good Piping Cost Estimates Demand Basic Understanding of Terms. E. J. Mark. *Heating, Piping & Air Conditioning 33,* 162 (1961) Jan. (4 pp.)

Developing estimating data for piping labor is a major concern to all engineers involved in the design, installation, or replacement of piping systems or components. Good cost estimates require an understanding of definitions of such terms as manhours expended—in relation to the proper assignment of labor time units to such items as fittings, flanges, system erection. All these must be related to the factors which will affect a difference in cost—for instance the effect of actual physical location of the installation.

Process Design

Equipment Costs. K. M. Decossas, S. P. Koltun and E. L. Patton. *Chem. Eng. Progress 56,* 60 (1960) Dec. (4 pp.)

Equipment costs, obtained largely from equipment manufacture during process evaluation over the past six years, have been classified by material of construction and size, plotted, and are presented for quick reference and use. These costs have been adjusted to the December 1959 level using the appropriate Marshall and Stevens equipment cost indices.

Safety

Enlightening City Officials on Operating Problems. E. Niederer, Jr. *Gas 37,* 63 (1961) Jan. (3 pp.)

Specialists from many parts of the country gathered in Seattle last June to attend Cascade Natural Gas Corp.'s second annual sales convention for independent gas appliance dealers, installers and city officials. Company believes that it is important that city officials be informed on operations and maintenance of a gas distribu-

tion system if cooperation is to be expected. Those in attendance witnessed a demonstration showing what happens when a main or service is broken or on fire and how the flow of gas is controlled and damage repaired.

Home Safety . . . A Challenge to the Gas Industry. D. J. Kerr. *Gas 37,* 53 (1961) Jan. (4 pp.)

Last year, a survey revealed that only 18 per cent of the *gas* users think that gas is safer, while 54 per cent think that electricity is safer. On the other hand, 2 per cent of the *electricity* users think that gas is safer, while 86 per cent think that electricity is safer. The public at large stacks up this way: 12 per cent think that gas is safer; 66 per cent feel this way about electricity; and 22 per cent admit that they just don't know. According to National Fire Protection Assoc. figures of U.S. building fires, gas caused less than 3 per cent, oil more than 11 per cent and electricity more than 13 per cent. The National Board of Fire Underwriters says gas is safer than oil by a ratio of 3.7:1, and safer than electricity by 8.9:1. Problem lies in the attitude of the public toward the safety of gas appliances, and this calls for action by the industry, says author.

The Operating Supervisor and Field Problems in Accident Prevention. J. C. Goes. *Pro. Pacific Coast Gas Assoc., Inc. 51,* 93 (1960) Sept. (2 pp.)

Most important part of an operating program, says author, is to acquaint a crew with the job at hand. Follow-up supervision is necessary from time to time to take care of details or changing conditions or situations. Most important requirement for a supervisor in conducting an accident prevention program is to be convinced himself of the importance and necessity of having such a program. It is, says author, team effort that makes an accident prevention program successful.

Safety in Pipeline Operations. N. Mork. *A.G.A. Monthly 42,* 31 (1960) Dec. (3 pp.)

Member of New York State Public Service Commission discusses maintenance problems of transmission and distribution engineers, and notes A.G.A. contributions to this field. Special mention is made of a portable test device, being developed by A.G.A., that would permit the automatic examination of lengths of pipe in the field to ascertain whether serious defects exist.

Space Heating

1961 Directory. Heating, Piping, and Air Conditioning Equipment. *Heating, Piping & Air Conditioning 33,* 395 (1961) Jan. (184 pp.)

Four-part directory contains products advertised in current issue classified in directory style; alphabetical product classification, along with names of manufacturers; product trade names alphabetized, identified with names of manufacturers; and names and addresses of all manufacturers.

Sulfur

Who'll Buy Canda's Sulfur? *Chem. Week 35,* 21 (1960) Dec. 17 (2 pp.)

Four new sulfur recovery plants are now being planned or built in Alberta. By the end of 1961 they will collectively add 1 million long tons/year to Canada's present 700,000-long ton/year sulfur capacity. It costs a minimum of $12/ton to move Alberta sulfur to the nearest waterways (the Pacific Ocean or the Great Lakes). Result: except in northern California and the Pacific Northwest, Canadian sulfur has not yet been able to compete with the Gulf Coast and Mexican products.

2. ENERGY SUPPLY AND ECONOMICS

Coal

Coal in the Future Energy Market. H. E. Risser. (Div, of the Ill. State Geological Survey, Circu. 310), 1960 (15 pp.)

Because of competition from other fields, the coal industry has declined even though total energy consumption has increased. Author believes that from now on, the coal industry will move forward. Competition, he says, will still prevent growth of coal in many uses, but projections of continued growth in its use for generating electric power will bring a significant increase in total coal consumption through the mid-1970's. This will help to strengthen the coal industry and enable it to face the opportunities and challenges of the last quarter of the twentieth century when the declining availability of oil and gas will open up new, and reopen old, markets.

Competition

Oilheating Sales Totalled 516,863. *Fueloil & Oil Heat 20,* 49 (1961) Jan. (8 pp.)

Total sales of automatic heating, oilburners, stokers, gas burners and electric heating aggregated 1,826,150, a drop of 11 per cent from the 2,061,632-total registered in 1959. All automatic heating sales, except electric heating, showed a decline: oilburners totaled 516,863 compared with 635,951 in 1959, a drop of 18.8 per cent; gas heating came to 1,170,740 installations compared with 1,320,440 in 1959, down 11 per cent; coal stokers dropped 20 per cent to a total of 10,947, and electric heating registered a 14 per cent increase to an estimated installation total of 127,600.

Electricity

Ten Ways We Fail to Meet Electric Competition. Part 2. Our Peril in Price Selling. C. C. Turner. *LP-Gas 20,* 31 (1960) Dec. (2 pp.); **Part 3. Our Failure to Know and Evaluate Electric Rates.** *LP-Gas 21,* 26 (1961) Jan. (3 pp.)

In both articles author stresses that gas industry does not study the facts behind competitive rates, but accepts at face value what electric competitors claim. His belief is that these rates should be studied and exposed, rather than be made the subject of worry. He cites several examples, including the "Beltsville Tests," to support his argument.

Energy Sources

Energy for Transportation. G. B. Warren and D. H. Brown. *Mech. Eng. 83,* 23 (1961) Jan. (3 pp.)

The National Academy of Sciences—National Research Council recently met to study the over-all U.S. transportation system. A proposed study in depth may lead to important technological, legislative, organizational and managerial suggestions looking toward an improvement in the effectiveness and efficiency of the transportation system. Some concept of the magnitude of transportation in comparison to the U.S. economy was approximated. Figures indicated that transportation costs for both goods and passengers are approximately 20 per cent of the gross national product.

Proceedings of the First Energy Institute. June 26–July 1, 1960. (Sponsored by School of Business Administration, the American University, Washington, D.C.) 221 pp.; $7.50.

Proceedings contain the papers and discussions presented at the first conference of its kind by specialists in the various basic energy sources. A total of seventeen papers on various current aspects of energy was presented. Topics included nuclear energy, water power, coal, petroleum and natural gas, and two special papers on the consumer's viewpoint. Records of discussions and three panels are included. Although the material is somewhat general, the treatments include excellent technical reviews and much statistical data, which give the reader up-to-date viewpoints on energy problems.

Fuel Cells

Fuel Cell Hits 60% Efficiency. *Business Week 1634,* 35 (1960) Dec. 24 (2 pp.); **Sodium Reaction Powers New Fuel Cell.** *Oil Gas J. 58,* 84 (1960) Dec. 26.

New kind of fuel cell, one that uses an amalgam of sodium in mercury and oxygen to produce electricity, has been revealed by M. W. Kellogg Co. Sodium-mercury cell's efficiency is 60 per cent, high when compared with such other fuel cells as the Hydrox or the Carbox. Westinghouse, in the meantime, has revealed an entirely new concept in power conversion. The company has found that certain combinations of ceramics and metals can produce electricity when they are heated. In the first test, the combination was a piece of iron coated with ordinary vitreous enamel, which in turn had a thin silver covering. At temperatures between 400°-1400°F, the combination produced power—at a rate of 16 milliwatts/sq. in. of the silvered surface.

Regenerative Fuel Cell System Investigation. J. M. Fuscoe, S. S. Carlton and D. P. Laverty. [Wadd Technical Report 60-442. (Thompson Ramo Woolridge, Inc., Report No. ER-4069) May (1960) Qualified requesters may obtain copies of this report from the Armed Services Technical Information Agency (ASTIA), Arlington Hall Station, Arlington 12, Va.]

Analysis of a nuclear regenerative fuel cell system, comprised of experimental and theoretical investigations of the component's performance, was conducted. A fuel cell, consisting of lithium and hydrogen reactants and an eutectic mixture of lithium chloride and lithium fluoride as the electrolyte, was selected for study on the basis of the regenerative characteristics of the fuel cell reaction products. The cell operating at 950°F and 1 atm of pressure gave an open-circuit voltage of 0.56 and produced a maximum of 1.59 w/sq ft of hydrogen electrode at 0.285 v.

Hydrogen

Tidewater's Big Hydrogen Plant. D. H. Stormont. *Oil Gas J. 59,* 90 (1961) Jan. 9 (2 pp.)

Progress report describes plant which consists of two essentially parallel units of 15-MMCF/day capacity. In the reforming furnaces, the hydrocarbon feed and steam are converted into hydrogen, carbon dioxide and carbon monoxide. Effluent composition of about 80 per cent hydrogen, 10 per cent CO and 10 per cent CO_2, is obtained. Upon leaving the reforming furnaces, the hot gases are cooled (by injecting condensate) and run to first-stage shift converters. There, more hydrogen is produced as a result of the steam-carbon monoxide reaction.

LPG

LP-Gas Brought Up-to-Date with a Look Ahead. P. W. Tucker. *LP-Gas 21,* 18 (1961) Jan. (8 pp.); **The Shape of Tomorrow.** W. W. Clark. *Butane-Propane News 23,* 27 (1961) Jan. (6 pp.)

LPG is no orphan; it's of age and into its second generation of growth, says author. The increasing use of pipeline and water transportation for LPG, plus increased storage capacity, will insure adequate supply to fulfill the rapidly growing domestic and industrial needs. Househeating and internal combustion should be among the most rapidly gaining uses of LPG, with air conditioning joining the upsurge.

Petroleum

World Wide Oil. *Oil Gas J. 58,* 97 (1960) Dec. 26 (54 pp.)

In 1960, the eyes of the oil world were focused on the expanding markets in Europe, and new oil being found in North Africa. Comprehensive report summarizes detailed information. In addition to the tabulations of production and refining data, short reports on the significant oil news from all the important oil areas of the world are included.

Solar Energy

Progress Report: Solar Energy in 1960. J. I. Yellott. *Mech. Eng. 82,* 41 (1960) Dec. (4 pp.)

Amounts of power which can be generated by feasible solar devices are so small, and the devices themselves are so costly, that the only really practical applications are in connection with space projects. A few installations of photoelectric converters for remote radio relay stations, harbor warning lights, etc., have been made both in the United States and Japan, but they can be justified only where the cost of replacing ordinary chemical batteries is prohibitive.

Thermoelectricity

Thermoelectricity as a Power Supply for Blowers and Pumps on Gas Heating Systems. R. W. Fritts. *Gas Age 126,* 34 (1960) Dec. 8 (3 pp.)

For the gas-heating industry today's conversion efficiencies are already adequate for a significant improvement on conventional heating equipment. Heretofore, all forced air and hot water gas-heating systems have required electrical connections for the operation of blowers and pumps. With the new thermoelectric materials available now in commercial quantities, the entire electric power requirements for operation of gas-heating equipment can be supplied directly from a thermoelectric generator mounted on the combustion chamber.

3. NATURAL GAS AND PETROLEUM PRODUCTION

Drilling

Care and Maintenance of Tool Joints (Part 3, Engineering Practices Manual No. 3). S. G. Marshall and C. R. Frederick. *World Oil 151,* 109 (1960) Dec. (5 pp.)

Tool joint threads and shoulders will sustain damage occasionally, despite the best efforts on the part of personnel to avoid it. If the damage is extensive or serious, the connection should be reworked by a qualified machine shop, or the tool joint replaced. However, most damage resulting from handling can be repaired on the rig with hand files, if the damage is detected early and corrected promptly. Basic idea in field repair of tool joints is to remove the trouble-making high spots, avoiding excessive filing of those areas that could eventually lead to tool joint failures.

Time-Setting Clay Cement Controls Lost Circulation. J. U. Messenger. *World Oil 152,* 110 (1961) Jan. (7 pp.)

Lost circulation to permeable sands, gravel and to very small fractures usually can be controlled by the use of bridging or plastering agents that are added directly to the drilling fluid. Recently a time-setting clay cement was introduced to the oil industry. This material has many properties for combating severe lost circulation, tendency to stick drill pipe, or contamination of drilling fluids. It has been successfully used where multiple fracture systems and small cavernous zones are present. New cement is easily prepared, placed and controlled as to the final properties of the slurry.

Exploration

High Drilling Costs, Varied Geology, Fail to Slow Arkoma Basin Growth. R. N. Planalp. *Oil Gas J. 59,* 124 (1961) Jan. 2 (5 pp.)

Arkoma basin is a relatively new name for the combined areas of the McAlester basin of Oklahoma and the Arkansas Valley basin of Northwest Arkansas. Recently, the Orr well discovered commercial gas nearly a mile deeper than any previous production in the basin, and also encountered bottom-hole pressures far in excess of any previous gage. The Orr well has almost assured the eventual testing of every major anticlinal feature in the southern portion of the Arkoma basin.

In Southeast New Mexico . . . Abo Reef Play Yielding Large Oil Fields. W. J. LeMay. *World Oil 151,* 91 (1960) Dec. (5 pp.)

Determination of back-reef and fore-reef facies via lithologic studies is the key to exploration along prolific trend. Production has been proven in important fields along a narrow 60-mile east-west regional trend in Lea and Eddy counties; prospects indicate that it will be extended eastward into Gaines County, Texas, and possibly farther westward along the Huapache Monocline in New Mexico.

Lower Paleozoic Prospects Enhanced in Sahara Area. *World Oil 152,* 71 (1961) Jan. (3 pp.)

New oil find at Hassi El Gassi in an important Cambrian sandstone field. Though smaller, it is similar in many ways to Hassi Messaoud. For example, discovery well was drilled in a refraction seismograph prospect. Semidetail refraction techniques have been developed in the Sahara. Production is from about 300 feet of Cambrian sandstone at about 10,500 feet not far above basement. Actually, Cambro-Ordovician sandstones cover much of the Sahara in Libya and Algeria. Exploration for these prospects is expected to continue for many years.

Rocky Mountain Four-Basin Report. Part 1. J. Kornfeld. *World Oil 151,* 99 (1960) Dec. (6 pp.)

Some of the most significant oil and gas discoveries in Wyoming's history were made late in 1959 and during 1960. As a result more than 35 per cent of the current wildcats being drilled in the Rocky Mountain region are in Wyoming. The major part of this activity is concentrated in the Green River, Powder River, Wind River and Big Horn basins. Article presents authoritative report on activity and geology of first two areas, along with maps and cross sections.

Rocky Mountain Four-Basin Report. Part 2. Wind River Basin and Big Horn Basin. *World Oil 152,* 101 (1961) Jan. (5 pp.)

Continuation of previous article describes activity and discusses geology of the two basins mentioned in title. Recent prolific discoveries have sparked new interest in these areas.

Geology

Geology of the Philippine Islands. B. M. Gozon. *Petrol. Eng. 33* (Drilling and Producing), B-65 (1961) Jan. (4 pp.)

Discovery of a commercial oil well in the Republic of the Philippines in late 1959 culminated 63 years of searching for oil in the vast archipelago. The discovery has brought impetus to exploration throughout the islands and has increased interest in the rather complicated geology of the Philippines. The major geologic features of interest to oil men are seven well-defined sedimentary basins located throughout the islands. The general geology of the principal basins is described.

Permeability

The Permeability of Sand Stabilized with a Chemical Grout. G. H. Dorion, H. Burkhard, and M. L. White. *ASTM Bull. (No. 250),* 34 (1960) Dec. (2 pp.)

In the development of AM-9 (American Cynamid Co.'s trademark) chemical grout, it became of interest to measure the water permeability of a grouted sand to get an indication of the general effectiveness of this grout in rendering soils impermeable. The results of experiments designed to measure the Darcy coefficient of permeability for sand treated with AM-9 are given. It is believed that the parameter described presents a relatively simple method for the determination of the permeability of highly impermeable materials.

Reservoir Engineering

Gas and Oil Segregation in Oilfield Reservoirs. H. Gilmour. *J. Inst. Petrol. 46,* 383 (1960) Dec. (8 pp.)

Prerequisites to effective conservation of energy arising from segregation are the geometric structure, which requires provision of a sufficiently large transition zone area, appreciable closure and dip of structure to minimize direct gas production from the gas-segregated zone, isotropic rock texture, so that vertical permeabilities are of the order of magnitude of that along the bedding planes, and the exercise of reservoir development and control, particularly with regard to selection of well locations in the structure and limitation of component pressure gradients in funicular gas and oil phases in the vicinity of the transition zones. Purpose of paper is to offer analytical expressions for instantaneous rate of segregation, for the criteria for its occurrence, and for consequent modification of the differential form of volumetric balance.

How to Correct Bed-Thickness Data from Directional Wells. B. V. Savoy and A. L. Valentine. *Oil Gas J. 59,* 68 (1961) Jan. 2 (5 pp.)

Electric logs from directionally drilled wells do not show the true thickness of the pay zones. Corrections must be made before isopach maps can be used for reserve evaluation. Article presents some methods applicable to crooked-hole fields.

How to Determine Permeability from Well Log Data. J. P. Johnson. *World Oil 151,* 88 (1960) Dec. (3 pp.)

Oil company has found a simple permeability interpretation technique based on information from well logs to be of valuable assistance when core data are lacking. Logs used are those commonly employed in salt mud systems, and include focused microdevices (microlaterolog), an independent porosity measuring technique (velocity or neutron) and a means of measuring R_t (laterolog or guard). Article discusses the method as applied to the San Andres formation of West Texas.

How to Find Reservoir-Oil Properties from Laboratory Fluid-Analysis Data. E. T. Guerrero and F. M. Stewart. *Oil Gas J. 59,* 92 (1961) Jan. 2 (5 pp.)

Properties of oil and gas mixtures are primarily functions of pressure, temperature, composition of gas, and composition of oil. No satisfactory analytical relations have been found to define these properties. They must be determined by laboratory measurement. For those cases where samples of the reservoir fluid were not obtained early in the life of a pool, fair estimates of the fluid properties can be obtained from empirical correlations and a knowledge of reservoir pressure, temperature, gas gravity and oil gravity.

Oilfield Interference in Aquifers of Non-Uniform Properties. M. Mortada. *J. Petrol. Tech. 12,* (Tech. Note 2071) 55 (1960) Dec. (3 pp.)

In studying oilfield interference, the variation in the properties of the aquifer must be taken into account to obtain reliable results. This is true because relatively small values of dimensionless time are involved in dealing with oilfield behavior. On the other hand, oilwell interference analyses usually involve fairly large values of dimensionless time because dimensionless time is inversely proportional to the area of the sink. For this reason, some attractive simplifications are permitted in dealing with oilwell interference. These simplifications, when applied to oilfield behavior, can lead to errors.

Physical Deliverability of Gas Reserves. I. I. Gardescu. *J. Petrol. Tech. 12,* 25 (1960) Dec. (5 pp.)

One of the main factors involved in the estimate of delivery is the computation of "physical deliverability" which shows the maximum rate at which a well can be produced under the existing characteristics of the reservoirs and lease operations. Thus, the physical deliverability is a ceiling beyond which a well or reservoir cannot be produced under given conditions. However, other restrictions may further curtail the rate of delivery below the estimated maximum physical deliverability volume. Deliverability study presented is an illustration of a workable method of estimating the volume of gas-well gas available under certain conditions.

Secondary Recovery

Displacement of Oil by Rich-Gas Banks. C. W. Arnold, H. L. Stone and D. L. Luffel. *J. Petrol. Tech. 12,* (Tech. Paper 8138) 305 (1960) Dec. (8 pp.)

Purpose of research is to determine 1) efficiency of small banks of enriched gas driven by methane in displacing oil from a porous medium and 2) effects of variation in bank size and composition of that efficiency. Most of the experiments were conducted in a sand-packed tube 20-ft long and ½-in. in diameter. The hydrocarbon system generally used was methane, butane and decane at 2500 psia and 160°F. Results indicate that, in the regions contacted by the gas, a small bank of an oil-miscible gas driven by methane can displace all of the oil in a pistonlike manner.

Well Practice

Nitrogen Can Improve Your Production Practices. R. A. Plummer and A. W. Smith. *World Oil 151,* 96 (1960) Dec. (3 pp.)

Liquid nitrogen units now in operation can deliver gas volumes of 175 MCF at pressures to 10,000 psi. The gas has proven advantages in these operations: well displacement on completion; perforating; acidizing; frac-

turing; spotting inhibitor, solvents or surfactants in the wellbore; cementing; controlling drilling mud weight in lost circulation areas; and testing surface equipment.

4. GAS CONDITIONING AND LPG RECOVERY

Hydrocarbon Removal

How to Add Refrigeration to Existing Gas-Processing Plants. C. P. Stanley. *Oil Gas J. 59,* 88 (1961) Jan. 9 (2 pp.)

Trend in gas-processing plant design has been away from atmospheric-temperature-absorption plants to refrigerated-absorption plants. Advantages are savings in plant fuel, reduction in capital investment, operating labor, and in operating difficulties due to absence of water. Actual plant case has been studied which is getting about 40 per cent propane recovery at atmospheric temperature absorption.

Hydrogen Sulfide Removal

Recording pH-Measurement in Ammoniacal Solutions of Oxysulfide of Arsenic to Control Thylox Plant. H. Mertens and T. Schuster. *Gas- und Wasserfach 101,* 1321 (1960) Dec. 16 (3 pp. German text.)

Thylox process is briefly described, and the significance of the *p*H value of the Thylox solution on results and economics of the process is noted. It is necessary to hold the *p*H factor to a minimum. This is fixed by the *p*H-dependent precipitation point of the arsenic sulfide. The *p*H value of the initial precipitation in Thylox solutions is given. Measurement expense for discontinuous gaging reproducible to ± 0.005 *p*H in the sulfided solutions in the laboratory and the continuously-recorded operating units is shown. Results of two years' operating experience are presented.

Nitrogen Removal

Gas Purification Method. C. Trepp (assigned to Sulzer Freres, S.A.) U. S. 2,958,203 (1960) Nov. 1.

Purification of a gas (hydrogen) is claimed by freezing out an impurity (nitrogen) in an indirect heat exchange system. The raw gas is admitted to a pair of exchangers, wherein the impurity deposits as a solid on the exchange coil in the primary unit. This impurity is thawed from the coil surface by warmed gas from the secondary exchanger (next in cooling series) and is removed as liquid.

Sulfur

Molten Sulfur Shippers Build for Their Biggest Year. *Chem. Week 88,* 54 (1961) Jan. 7 (2 pp.)

Prospects for doubled molten sulfur shipments in 1961 reflect redoubled determination of Frasch-process producers to counter inroads made by producers of "sour gas" sulfur. Right now, major suppliers are building or leasing new heated tanks for storing a total of over 200,000 tons of molten sulfur. In addition, they are readying three new tankers for service—together they can move around 45,000 tons at one time.

5. NATURAL GAS TRANSMISSION

Communications

Tips That Can Improve Your Microwave System. H. E. Smith. *Pipe Line Ind. 13,* 39 (1960) Dec. (4 pp.)

Maintenance of a microwave system begins with well-kept records, says author, which contain sufficient data for predicting component and unit failures. This permits corrective actions to begin before an outage or malfunction occurs. Records of meter readings taken during routine visits to each station supply accumulative data which are necessary to evaluate system and unit performance. This information, when correlated with expectations and past experiences, points out potential failures. The data taken during the initial installation provide a continuous reference.

Compressors

AXI-Compressors in Action in Field Service. *Gas Age 126,* 36 (1960) Dec. 8 (2 pp.)

Three packaged axial-flow, positive displacement units are in field gathering service in Mississippi. They were installed to reduce suction pressure at Shell's new 5000 MCF/day processing plant. They are believed to be the first of their kind in such service and offer a number of advantages.

New Engines from Old. R. N. Talley. *Gas 37,* 101 (1961) Jan. (6 pp.)

Pacific Lighting Gas Supply Co.'s Ventura compressor station houses ten 760-hp compressor units which were originally installed in 1927. After some thirty years of continuous operation, it became apparent that extensive repairs would be required for economic operation. Company decided on an extensive reconditioning program. With seven of the units overhauled, repairs and downtime have been reduced dramatically at a fraction of the cost of new horsepower.

Compressor Stations

Compressor Station Operation. C. W. Frank. *Pipe Line News 32,* 36 (1960) Dec. (4 pp.)

Discussion of compressor stations operated by Houston Texas Gas & Oil Corp. on their Texas to Florida natural gas pipeline. With the exception of one 2500-hp unit on the Coastal Transmission Corp. end of the line, all of the reciprocating-type units are 2000 hp in size. Company has eight stations on its entire system: one station 2500 hp, two stations 4000 hp, and five stations 6000 hp each.

Desert Pipeline Pumping Station. *Gas and Oil Power 55,* 285 (1960) Nov. (2 pp.)

Pumping station at Haoud el Hamra (Africa) operates one diesel engine to push the oil up the first rise; at M'sila station two engines are needed to lift the oil to the highest point on the line, after which the line

drops down to sea level in 79 miles. At the pumping stations, power is provided by 16-cylinder diesel engines. Each engine has a continuous rating of 2083 bhp at the ambient temperature of 120°F, and is arranged to drive a centrifugal pump through a gear box. Engine accessories at Haoud el Hamra, because of fuel and climate, are unusual.

Fluid Flow

Pipeline Efficiency Tests. J. K. Duvall and A. J. Marushack. *Pro. Pacific Coast Gas Assoc., Inc. 51,* 94 (1960) Sept. (4 pp.)

Pipeline efficiency tests of Mountain Fuel Supply Co.'s transmission lines were conducted during the winter seasons of 1958-60 to determine the condition of the lines' internal surface. Tests were of the tracer-type using liquid Freon 12 injected at high pressure directly into the gas stream. Data obtained in the field were used to calculate efficiencies of the various pipeline sections. Tests indicated that the over-all efficiency of the pipeline is close to that of new steel pipe.

Measurements

Profits from Gas Measurement Operations. H. H. Shelton. *Pro. Pacific Coast Gas Assoc., Inc. 51,* 102 (1960) Sept. (2 pp.)

Author claims that automation is no longer something to be tried in gas measurement; rather, he believes, it is a question of proper application. Benefits of automation in his company include: approximately 800 man-hours/month saved in the field; 600 overtime hours/month saved in the office; increased handling (40 per cent) of charts with the same personnel as five years ago. Some work hours have been added to the data processing department, but the over-all savings more than compensate for these.

Pipeline Construction

Construction of 24-inch Gas Line from C. Pemex to Mexico City. F. X. Peredo. *Pipe Line Ind. 13,* 22 (1960) Dec. (5 pp.)

New 481-mile line crosses swamps, deep lagoons, rock and mountains plus populated areas to bring Pemex gas to major industrial areas in Central Mexico. Main line consists principally of 24-in. API 5LX Grade X-52 cold expanded 0.344-in. wall pipe, factory welded by the submerged arc process. Pipe of 0.438-in. wall thickness is used near populated areas and 0.625-in. wall pipe was used for the underwater river crossings. The 128,000 U. S. short tons of pipe necessary for this line were fabricated in Monterrey. Entire project will be in commercial operation by March.

Correlation Between Pipeline Diameters Answering the Same Purposes but Transmitting Various Gas at Various Pressures. P. Albrieux. *J. Ind. du Gaz 84,* 471 (1960) Nov. (4 pp. French text.)

Computations of mains and service pipe diameters for gas supply in various suppositions which take into account an allowance of the constant amount of therms to be supplied.

French Prefabricate Five-Line Crossing of the Seine. A. Gibbon. *Pipe Line Ind. 13,* 27 (1960) Dec. (3 pp.)

Five-line crossing of the Seine River in Paris was prefabricated, barged into place, and lowered to the bottom by heavy barged cranes. Although the lines were concrete-coated to provide negative buoyancy, additional weights were used during the sand backfill. After a good portion of the backfill was in place, the weights were removed. Following the five feet of sand cover, cobble stones were heaped over the crossing as an added protection.

Natural Gas. Part 3. The Construction of Long Distance Transmission Lines for Natural Gas. A. N. Sharp. *Coke and Gas 22,* 510 (1960) Dec. (5 pp.)

Author discusses the worldwide exploitation of natural gas deposits and the international impact of this fuel on the postwar gas industry. In the current article of series, he discusses steps in long-distance transmission line construction: route survey; right-of-way preparation; unloading, storing, handling and stringing; trenching; welding; coating and wrapping; laying; and final testing.

Turnagain Arm Crossing Fails. K. M. McClain. *Pipeline Eng. 33,* D-42 (1961) Jan. (3 pp.)

Tides, swift current, strong winds, and oozing mud stymied completion of the 85-mile, 12-in. dual pipeline of the Anchorage Natural Gas Corp. and Alaska Pipeline Co. Not the longest pipeline in the world, but one of the most unique, this is the connecting link with the transmission line from the gas wells in the Kenai Peninsula—210 miles by highway or 85 miles straight across the Inlet—to the distribution system at Anchorage.

Pipeline Operations

Pipe Line Cleaner. K. C. Cribley (assigned to Champlin Oil & Refining Co.) U. S .2,959,798 (1960) Nov. 15.

Improved pipeline cleaner is claimed consisting of a frame with spaced spring arms mounted as a front and rear set. The spring arms each terminate in a base plate on which is mounted pairs of small shafts carrying groups of rotary V-tooth disks, spaced to rotate independently. Behind each pair of shafts is a "follow-up" shaft with similar disk cutters. Arms and cutters are spaced to contact most of the internal periphery.

Telemetering

Instrumentation, Controls, and Automation. Part 4: Telemetering. M. T. Nigh. *Pipeline Eng. 33,* D-45 (1961) Jan. (4 pp.)

Current installment is concerned with sequencing of analog telemetering. Topics discussed: distributor for sequencing; graphic means of showing sequential signals; electronic speed analog telemetering; accuracy and security considerations; and signal conversions for variable frequency telemetering.

6. GAS AND LPG STORAGE

LPG

Transportation and Storage of Liquefied Petroleum Gases. *Fuel Efficiency 8,* 37 (1960) Dec. (4 pp.)

Thousands of tons of propane are delivered annually by Shell-Mex and BP Gases Ltd., Britain's largest distributor of LPG to industry. Bulk deliveries are made direct from the refineries, and the road tankers are equipped with engine-driven pumps used to discharge into the customer's storage tank through a flexible hose. The flexible hose has a special coupling which enables the discharge to be effected quickly, without loss of product. Vehicles have three capacities: 1800, 2000 and 4000 gallons.

Methane Liquefaction

Liquefying Natural Gas with Low Pressure Refrigerants. L. K. Swenson and J. De Lury (assigned to Conch International Methane Ltd.) U. S. 2,960,837 (1960) Nov. 22.

Natural gas is liquefied by an improved process in which the compressed gas stream is passed in heat exchange with a series of refrigerants at progressively decreasing temperatures. Each refrigerant is alternately compressed, condensed and expanded in a separate cycle. The said expanded refrigerants are passed in liquid form in heat exchange with the process stream to extract its latent heat. The final refrigerant is liquid methane, produced by condensation. A special stage includes distillation of nitrogen from the condensed methane stream.

Storage

LPG Tankship Refrigeration System. F. L. Maker (assigned to California Research Corp.) U. S. 2,959,928 (1960) Nov. 15.

In a tankship method of transporting LPG, an improvement is claimed. LPG vapor from the vapor space of the tank is withdrawn and condenses to liquid. The liquid, cooled by expansion, is used as a refrigerant in a coil centrally located in the tank. The cooled central column of tank contents circulates downward and causes warmer liquid at the outer wall to move inward for cooling.

Underground Storage

Can Gas Be Stored Under Flat Caprock? *Petrol. Week 11,* 30 (1960) Dec. 23 (2 pp.)

Project aimed at solving problems involved in storing natural gas underground under water pressure beneath flat caprock is under way in the Chicago area. Large quantities of gas are now stored underground in water-bearing sandstone formations under domes of impermeable caprock in various parts of the country. Perhaps the best known gas-storage aquifer of this type is Herscher Dome, of Peoples Gas Light & Coke Co., at Herscher, Ill. Success of the experiment, being conducted by Northern Illinois Gas Co., could mean more underground storage of gas near markets because of the wider prevalence of flat caprock formations.

7. MANUFACTURED GAS AND CHEMICAL PROCESSING

Acetylene

Process for Using Shock Waves to Produce Acetylene. P. H. Lahr and H. Lamprey (assigned to Union Carbide Corp.) U. S. 2,958,716 (1960) Nov. 1.

Improved production of acetylene from methane and other hydrocarbon gases is claimed for a shock wave process. In the process a detonating mixture is fired at one end of a shock wave reactor, and a make-gas of hydrocarbons and other gases is introduced at the other end. The two zones are separated by a thin rupturable diaphragm, and the acetylene produced is withdrawn near the position of the diaphragm.

Shock Tube Experiments on the Pyrolysis of Acetylene. G. B. Skinner and E. M. Sokoloski. *J. Phys. Chem. 64,* 1952 (1960) Dec. (2 pp.)

It appears that in the range of temperatures and pressures studied the first step in acetylene decomposition is dimerization. The subsequent steps have not been defined, but probably involve further polymerizations and condensations to produce benzene and condensed aromatic compounds which eventually may be thought of as carbon.

Aromatics

Purification of Benzene by Removal of Thiophene and CS_2 with NaK Alloy. O. L. Wright and F. J. Vancheri. *Ind. Eng. Chem. 53,* 15 (1961) Jan. (4 pp.)

Rate of thiophene removal depends on temperature, alloy composition, amount of alloy present, and mixing efficiency. With a laboratory dispersator and 1-2 percent (weight) NaK in the reactor, 260 ppm of thiophene were reduced to 1.5 ppm after a holdup time of 15 min at 80°C. Laboratory results indicate that the process can be operated batchwise or continuously, and preliminary scaleup design indicates that a relatively simple and inexpensive installation is required.

Coal Gasification

Comminuted Solid Fuel Introduction into High Pressure Reaction Zone. A. B. Steever (assigned to Babcock & Wilcox Co.) U. S. 2,961,310 (1960) Nov. 22.

High-pressure gasification process is claimed with an improved feed of coal in water suspension. This slurry feed is sprayed into an upper hot zone falling downward to a lower hot zone, with gasification occurring in both. The refractory walls are lined with banks of water tubes to generate them. Outlet synthesis gas is cleaned by cyclones with solids returned to the lower hot zone for slagging.

The Gasification of Coal Fines. L. Jequier, L. Longchambon and G. van de Putte. *J. Inst. Fuel 33,* 584 (1960) Dec. (8 pp.)

Theoretical study of the gasification of coal and of the fluidization technique suggests that this technique might help to solve the problem of the gasification of fines.

Group of French companies made it possible to carry out laboratory tests and later, with the help of the Centre d'Etudes et de Recherches des Charbonnages de France, to build and operate a big pilot plant. Circumstances, however, did not allow more than short and insufficient tests to be conducted with this plant. Work done, however, indicates that it would now be possible to design, build and operate an industrial generator, because most of the difficulties found in the pilot plant, such as coal feeding, dust separation and reintroduction, recuperation of the sensible heat of the gas, and which occur in similar industrial application have been satisfactorily overcome.

Laboratory-Scale Gasification of Coal-Water Slurries in a Metallic Tube Coil. J. L. Konchesky, R. F. Stewart and J. J. S. Sebastian. *U. S. Bur. Mines Rep. Invest. 5704.* 1960 (29 pp.)

Technical feasibility of gasifying powdered, noncoking, low-rank coal with steam in an externally heated tube has been demonstrated. The tube, 112 feet of alloy-steel tubing shaped into a helix, served as an electrical conductor of electricity used for heating. Reaction pressure was maintained in the range 19-26 psia while variables were studied. High carbon conversions and large yields of synthesis gas were obtained with low-rank coal. In one test, for example, about 88 per cent of the carbon in a subbituminous C coal was gasified at 1910°F with a residence time of 1 sec. The gas contained 58% H_2, 19% CO_2, 15% CO, and 3% CH_4; the field was 30 CF (at 32°F and 14.7 psi) of synthesis gas ($CO + H_2$) per pound of dry coal.

Possibilities of Using Nuclear Energy for Gasifying Coal. J. P. McGee and S. Katell. *U. S. Bur. Mines Inf. Cir. 7965,* 1960. (Washington, D.C.: U. S. Govt. Print. Off., $.15; 11 pp.)

Proposed system for gasification is the indirect process cycle with helium heated in a nuclear reactor and passed through an exchanger-type gasifier for the reaction of coal and steam to form CO and H_2. A conceptual design of a system to produce 14 MMSCF/hr of $CO + H_2$ which could be further processed to produce 90 MMSCF/day of high Btu gas is described. The process involves the gasification of 311,000 lb/hr of a low-rank coal. The process heat required would come from three 250-thermal megawatt reactors, using slightly enriched uranium as fuel.

Process for the Gasification of Solid Carbonaceous Fuels. H. V. Atwell (assigned to Texaco, Inc.) U. S. 2,963,354 (1960) Dec. 6.

In the generation of carbon monoxide and hydrogen by partial combustion of fine solid fuels with oxygen, an improvement is claimed in the mixing of reactants. With the steam-suspended fuel and the oxygen stream injection flow held first at a higher velocity and later at a lower velocity than the rate of flame propagation, an unstable flame is maintained. This flame generates a resonant frequency vibrating at 50-500 cycles, which serves to strip stagnant gas films from coal and to mix the reacting gases in the main reacting zone.

Coke

Review: Development of the Production of Metallurgical Fuel from Brown Coal. G. L. Kennedy. *J. Inst. Fuel 33,* 598 (1960) Dec. (11 pp.)

Review describes recent work in Australia. Because of the low rank of brown coals, the carbonization techniques required for their upgrading are quite distinct from those of conventional coke-oven practice. The relatively new technology had its origin in the German low-temperature carbonization industry for the recovery of brown coal tar. Carbonization of brown coal briquettes to produce a strong lump char, as a fuel equivalent to hard coke, his been undertaken in the last decide on a large scale in East Germany and on a more moderate scale in Victoria. There is an important difference in the emphasis placed on the briquetting and carbonization stages of the process: in Victoria, more emphasis is placed on the protection of the briquette structure during carbonization.

Ethylene

Ethylene Production Process. K. Peters. U. S. 2,960,518 (1960) Nov. 15.

Improved process and catalyst for production of ethylene from carbon monoxide and hydrogen are claimed. The catalyst, operating at 350°-520°C, is of four components: chromium oxide activated with Zn0; cobalt; alumina or kieselguhr; and potassium oxide.

Fischer-Tropsch

Catalytic Hydrogenation of Carbon Monoxide. W. Rottig and W. Wischermann (assigned to Ruhrchemie Akg. and Lurgi Ges. f. Warmetechnik m.g.H.) U. S. 2,957,-902 (1960) Oct. 25.

In a process for catalytic hydrogenation of carbon monoxide using fixed-bed iron nickel and cobalt catalysts, an improvement is claimed which comprises removal of high molecular weight waxy products from the catalyst surface. This consists of a flushing extraction of the bed with 0.4-2.5 times its volume of an oil boiling between 180° and 320°C. The extraction oil is preferably a neutral fraction consisting of the synthesis product oils.

Fluidization

Pressure Drop and Power Requirements in a Stirred Fluidized Bed. M. Leva. *A.I.Ch. E. J. 6,* 688 (1960) Dec. (6 pp.)

Paper reports fundamental observations on the effect which stirring of fluidized solids has on the pressure drop. Typical power requirements are also given. The observations disclosed that blade positioning relative to sense of rotation had a very profound effect on pressure drop as well as on power requirements. When the solids circulation pattern as normally induced by the stirrer was of the same general character as that ordinarily encountered in a dense phase fluidized charge, the resulting pressure drop was always considerably lower than that of the conventional unstirred fluidized bed pressure drop.

Hydrocarbons

Applied Hydrocarbon Thermodynamics. Part 24: Liquid Phase Fugacity and Activity Coefficients. W. C. Edmister. *Petrol. Refiner 39,* 159 (1960) Dec. (10 pp.)

Theoretical prediction of the vapor-liquid equilibrium phase distribution ratios involve evaluating the fugacities of the components in both vapor and liquid phases. The terms may be arranged in different ways so that these evaluations may be used to find either fugacity coefficients or activity coefficients. For many calculations the fugacity coefficient $\varnothing$ is satisfactory. The fugacity coefficient of a liquid phase component can be found from PVTC data by an equation of state whereas the activity coefficient cannot be found by theoretical means from volumetric data.

Benzene Formation During Oil Gasification in Hydrogen. P. J. Owens, R. Long and F. H. Garner. *Ind. Eng. Chem. 53,* 10 (1961) Jan. (5 pp.)

Pure hydrocarbons were used to study the formation of benzene, an important byproduct of gasification by thermal hydrogenolysis. Temperatures of 500°-800°C and reaction times of 5-40 sec were used at 10 atm of pressure. The benzene-forming reactions included dehydrogenation of cyclohexane and methylcyclohexane, and isomerization, followed by dehydrogenation, of methylcyclopentane. Benzene was also formed from *n*-heptane by a mechanism which still is obscure. The gas-forming reactions in all cases were those expected of thermal cracking in the presence of hydrogen.

Get Equilibrium Data This Easier Way. R. R. Neyrey. *Petrol. Refiner 39,* 129 (1960) Dec. (6 pp.)

Nomographs presented were developed to meet the need for an accurate and quick method for obtaining equilibrium data. The method uses only two constants, a slope and an intercept, on a chart representing equilibrium data for all components. The nomographs are applicable for olefin and paraffin hydrocarbons over a wide range of conditions.

Hydrocarbon Oxidation with 95% Oxygen. J. M. Robertson. *Chem. Eng. Progress 56,* 64 (1960) Dec. (3 pp.)

Direct addition of O_2 to an aliphatic hydrocarbon molecule by noncatalytic means has been attempted by many. However, process discussed is the only one which has reached the stage of successful commercial development. Purpose of article is to show that under the proper conditions, vapor phase noncatalytic oxidation of hydrocarbons with 95 per cent O_2 can be practical on a commercial scale.

Hydrogen

Large Surface Area Hydrogen Permeation Cell. J. B. Hunter and G. M. Hickey (assigned to Atlantic Refining Co.) U. S. 2,961,062 (1960) Nov. 22.

Diffusion-type apparatus is claimed with an improved permeation unit. This is comprised of bundles of fine ($\frac{1}{32}$-$\frac{1}{8}$-in.) tubes of silver-palladium alloy with walls 0.001-0.005-in. thick. The bundles pass through a tubesheet at either end of a closed chamber. Raw gas feed in a space between the tube sheets loses hydrogen into the fine tubes, which lead the hydrogen to collection domes at each end.

Which Process Best for Producing Hydrogen? G. R. James. *Chem. Eng. 67,* 161 (1960) Dec. 12 (6 pp.)

Author believes it would be presumptive to specify any single hydrogen process as the best—first, because of the many process steps involved; second, because many of the process alternatives en route will fit some requirements and not be suitable for others. For this reason, five flow schemes have been selected as logical combinations of the several possible steps in hydrogen manufacture. These methods contain four basic steps: raw hydrogen purification; CO conversion; CO_2 removal; and final purification.

Methane

Chemicals from Methane in a High Compression Engine. P. E. Oberdorfer and R. F. Winch. *Ind. Eng. Chem. 53,* 41 (1961) Jan. (4 pp.)

Very rich methane-oxygen mixtures were partially oxidized under controlled conditions in a high-compression motored engine reactor. The chemical products of oxidation in order of amount were methanol, formaldehyde, and formic acid, totaling up to 50 per cent of the methane converted. Carbon monoxide and hydrogen were also formed. The higher hydrocarbon components present in small amounts in natural gas were selectively dehydrogenated to the corresponding olefins.

Olefins

Peracetic Acid Process Opens Way to Wide Range of Epoxides. D. H. Stormont. *Oil Gas J. 58,* 78 (1960) Dec. (2 pp.)

Union Carbide's new 10-million lb/yr plant at Institute, W. Va., represents the first commercial use of peracetic acid to produce epoxies from olefins and other unsaturated materials. Of particular interest are the unusual safety measures taken in handling the highly reactive, potentially explosive acid.

Ore Reduction

(Reduction of Powdered Iron Oxide) A Vertical Flow Reactor. W. A. Lloyd and N. R. Amundson. *Ind. Eng. Chem. 53,* 19 (1961) Jan. (4 pp.)

Iron oxides entrained in hydrogen were reduced during transport through an electrically heated tube. The time required to obtain in excess of 90 per cent oxygen removal varied from less than 2 to more than 15 sec, depending on the oxide and the temperature of operation. A rate-acceleration effect was observed in the initial phase of the reduction process, but reduction rate decreased with increasing temperature at 550° - 700°C for Fe_2O_3 and Fe_3O_4. The wustite phase was observed in oxides reduced below 570°C, the temperature which defines the lower limit of the stable wustite region.

(Reduction of Powdered Iron Oxide) A Tubular Reactor. I. G. Dalla Lana and N. R. Amundson. *Ind. Eng. Chem. 53,* 22 (1961) Jan. (5 pp.)

Use of a specialized technique for reduction of iron ores has permitted use of fines as a raw material and yielded a nonsintered powder product. Studies involving the reduction of a ferric oxide powder by entrainment with hydrogen in a vertical tubular reactor were continued with a powder containing larger particle sizes (2 - 16 microns). The mechanism of the chemical reduction appears to change from a chemical to a diffusional regime. Within this framework, qualitative explanations are possible for the phenomena observed during the reduction.

Shale Oil

Method of Pyrolysis of Fuel. O. E. A. Aspegren (assigned to Oil Shale Corp.) Reissue 24,894 (1960) Nov. 8. [Original Patent U.S. 2,788,313 (1957) Apr. 9.]

Continuous pyrolysis process for oil shale and other solid fuels is claimed in which heat transfer is effected by mixing the particles of raw shale with hot agglomerated solid bodies in the rotary furnace. These bodies are formed from the shale residue by partial combustion in a separate vessel, then blended with fresh residue and rolled in a pelletizing plant. The pellets are fed at pyrolyzing temperature to the rotary furnace. Cooled pellets are preheated by waste combustion gases.

8. GAS DISTRIBUTION

Distribution Systems

Special Aspects of Conveying and Distributing Natural Gas and Natural Gas Mixtures in Pipe Lines. F. Herning. *Gas- und Wasserfach 101,* 1150 (1960) Nov. 4 (7 pp. German text.)

On the hypothesis of equal heat transport, which is the only decisive assumption that gives a comparative estimate of fuel gas transmission, it is established that natural gas, because of its hydraulic properties, offers advantages over long-distance pipeline gas (Ferngas). It is shown that besides pipe friction and compressibility, the Wobbe number is of significance, and a unit known to play an important role in combustion technology. Its influence is especially apparent by inspection of natural gas-air mixtures since in this case the Wobbe number alterations give wide variation possibilities. Only by comparison of the losses in local supply networks is natural gas clearly surpassed by the line or city gas. Here, beside the necessity for an increased network pressure, the Wobbe number works out again but now in a way disadvantageous to natural gas.

Leakage

For One Geophysical Contractor, Diversification Is Key to Survival. P. B. Bike. *Oil Gas J. 58,* 208 (1960) Dec. 26 (2 pp.)

Diminishing income caused one geophysical firm to successfully enter a new line of endeavor. After merger with another company, efforts were concentrated on development of an instrument which could detect gas leaks at the surface. It was especially adapted for gas mains of public utilities. The air near the surface of the ground is continually sampled. The sample passes through various filters to the infrared analyzer sensitized to methane, and then on to a recorder which makes a paper record of the survey.

Mains

Cutting the Cost of Cast-Iron Clamping. R. A. Hansen. *Pro. Pacific Coast Gas Assoc., Ind. 51,* 77 (1960) Sept. (4 pp.)

Author's purpose is to consider the cost reduction that can be obtained in the installation of bell-joint leak clamps on cast-iron mains. Cost reduction is dependent on longer, effective life of clamps in service. Presentation is based on the assumption that clamps have a limited period of effective service life. Some of author's proposals may add to the unit cost of installing a bell-joint clamp; however, end result is a reduction in overall cost of clamping on cast-iron mains.

Mobile Light Boom for Cast Iron Pipe Handling. J. Heraud. *J. Ind. du Gaz 84,* 475 (1960) Nov. (2 pp. French text.)

Exhibition of a new hoisting equipment for cast-iron pipes. This boom, of one metric ton deadweight, allows lifting of a load up to 500 kg and handling of tubes up to 300 mm diameter.

Plastic Piping

Plastic Pipe as Service Replacement Inserts. W. S. Fielder. *Pro. Pacific Coast Gas Assoc., Inc. 51,* 71 (1960) Sept. (3 pp.)

Arizona Public Service Co. provides natural gas service to 183,000 customers in a service area of approximately 40,000. To date, use of plastic for service replacement has caused no modification in the operation of company's distribution system. The ⅝-in. size has proved to furnish sufficient capacity to homes and small businesses, and the pressure limitations are within those already imposed on the system. Although experience with plastics is still limited, company has realized installation economics.

Service Renewal by Plastic Insertion. J. P. Heckendorn. *Pro. Pacific Coast Gas Assoc., Inc. 51,* 70 (1960) Sept. (2 pp.)

Public Service Co. of Colorado's experience in the field of service renewal by the plastic insertion method dates back to 1954. Method was adopted to streamline service renewal program in order to keep pace with the increasing volume in this type of work. Experience has been very satisfactory: 4616 services (approximately 323,000 ft) have been renewed since 1954. In 1959, 1015 services, representing about 76 per cent of the entire program, were renewed by plastic insertion.

Weather Forecasting

Calculator for Gas Dispatching. M. D. Barr and W. J. Gunderson. *Gas Age 126,* 28 (1960) Dec. 8 (4 pp.)

Description of an 11-scale circular calculator and equation developed by Central Hudson Gas & Electric Corp.

to ease the problem of forecasting daily and one-day-in-advance loads. Principle of both equation and calculator is that any change in today's weather as compared to yesterday's can be related directly to gas sendout.

9. GAS FUEL UTILIZATION AND APPLIANCES

Air Conditioning

Influence of Unshaded Window Area on Selection of Peripheral Air Conditioning Systems. A. L. Jaros, Jr. *ASHRAE J. 3,* 66 (1961) Jan. (4 pp.)

Least expensive to install, under each of three stated ratios of window area to building facade, is the single-duct (all-air) system, although this is cited as being the least effective of the five systems considered. Of the other four, the least expensive when vertical distribution is feasible, are those with peripheral units, with induction systems noted as being more economical than fan coil units. The radiant ceiling system, more costly in buildings with large window expanses, becomes the least costly when window area is less than 25 per cent of the building facade.

Air Pollution

Progress Review No. 48: Air Pollution. A. Marsh. *J. Inst. Fuel 33,* 609 (1960) Dec. (7 pp.)

Review outlines the present situation and the progress made since 1950, mainly from the background of the Report of the Beaver Committee and the Clean Air Act 1956. The investigation and measurement of air pollution are briefly discussed, followed by a review of the Act and progress being made under it in the industrial and domestic fields. Transport pollution, mainly that from road vehicles, and the problem of sulfur emissions are also discussed and the review concludes with a note on air pollution as an international problem.

Burners

The Ignition and Control of Tunnel Burners. P. G. Atkinson and R. A. Hancock. Gas Council Res. Comm. GC 69; *Gas World 152,* 736 (1960) Nov. 19 (2 pp.); *Gas Times 94,* 34 (1960) Dec. (2 pp.) **Discussion.** *Gas World 152,* 784 (1960) Nov. 26 (2 pp.)

Method of applying electrical ignition to tunnel burners with a fully aerated mixture is presented. Design data for the application of this method of ignition to practical burners are included. Development of a suitable commercial unit for use in a timed ignition cycle of two seconds is described. In using a burner, it is usually necessary to vary its throughput, and several ways of doing this are considered with particular emphasis on air blast tunnel burners. Complete burner systems, both manual and automatic, are given that include combinations of ignition with safety and throughput control.

An Investigation of Tunnel Burner Noise. J. K. Kilham, E. G. Jackson and T. J. B. Smith. Gas Council Res. Comm. GC 74; *Gas World 152,* 746 (1960) Nov. 19 (2 pp.); *Gas Times 94,* 24 (1960) Dec. (2 pp.) **Discussion.** *Gas World 152,* 856 (1960) Dec. 10 (2 pp.)

Review of the literature on the mechanism of noise production in combustion systems indicates that, in the case of tunnel burners, the oscillations are governed by the Raleigh criterion, coupled with the possibility of standing waves in the mixture supply network. In order to investigate this hypothesis, a series of simplified single-port tunnel burners were constructed. Results obtained confirm the postulated mechanism and indicate that the upstream conditions exert a dominant effect on the generation of organ-pipe oscillations. The perforated-back plate type of tunnel burner was chosen for full-scale investigation since it is notoriously prone to noisy combustion. Effects of varying parameters are presented.

New Concept in a Pressure Burner. J. W. Schulz. *Fueloil & Oil Heat 20,* 70 (1961) Jan. (3 pp.)

Pressure burner described proved early in its history to have additional advantages over other burners then competing with it for popularity. It features a gear-type pump able to lift oil from a storage tank distant from and lower than the burner. It had no moving or motor-driven parts affected by heat from the oil flame. It had no moving oil-handling or oil-distributing parts having oil-wet surfaces on which carbon formed, by action of flame heat, with the burner operating or following a shutdown.

The Stability of Air Blast Tunnel Burners. W. E. Francis and M. L. Hoggarth. Gas Council Res. Comm. GC 68; *Gas World 152,* 743 (1960) Nov. 19 (3 pp.); *Gas Times 94,* 27 (1960) Dec. (2 pp.)

Experimental study has been carried out on the stability of air blast tunnel burners. In order to obtain consistent stability diagrams, it has been found necessary to use a standardized test procedure. The limits of weak and rich blow-off have been found to be considerably removed from the stoichiometric air: gas ratio and, consequently, blow-off is unimportant in normal operation of tunnel burners. The extent of the zone of instability due to lightback has been found to be dependent on the mixture-nozzle temperature, but, of various cooling methods tried, only water cooling seems effective in giving an appreciable reduction of the gas rates at the instability limit. Attention was, therefore, concentrated on instability rates for burners of orthodox construction and without special external cooling methods.

Gas Fired Burner. N. Barnes, N. W. Rickwood and R. G. Sargent (assigned to Ascot Gas Water Heaters Ltd.) U.S. 2,959,217 (1960) Nov. 8.

Improved burner for gas-fired appliances is claimed which comprises a flared sheet metal burner mouth connected centrally to a gas supply pipe. A series of longitudinal baffle strips spaced close to each other are placed in the shallow cupped flares of the burner mouth. These strips vary in depth, increasing from the outer end to the center of the burner, to provide frictional resistance to flow and thereby a more uniform flame height over the burner.

Principles of Secondary Aeration of Atmospheric Gas Burners. E. J. Weber. *A.G.A. Lab. Res. Bull. 84,* (Proj. DA-2-GU) Nov. (1960) $2.00 (42 pp.)

Results of the investigation reported provide a guide for obtaining minimum secondary aeration for complete combustion, with its attendant advantages, as well as for correcting conditions causing combustion failures. Complete combustion with a minimum of secondary aeration is dependent on minimizing recirculation of combustion products which is normally inherent in atmospheric combustion systems. The causes of such recirculation and the influence on recirculation of such factors as combustion chamber configuration, baffles, fuel input rate, primary aeration and secondary aeration are discussed.

Stove Burner. J. R. Williams and J. S. Shute (assigned to Selas Corp. of America.) U.S. 2,960,980 (1960) Nov. 22.

In a gas range, an improved top cooking burner is claimed. Unit is self-contained, comprising an upper sealed combustion chamber, a central gas-air inlet with a lower gas and air supply, and an ignition device. The upper chamber, sealed with a Vycor plate, is fed with central secondary air and annular primary gas-air channels. The gas-air mixture burns in radial channels in a ceramic disk below the Vycor plate, and combustion gases are drawn through multiple peripheral grooves downward into a lower channel which exhausts by fan to a ventilator. The igniter, exhaust tube and gas inlet are designed to register with proper connections on a lower supporting frame.

Combustion

Kinetics of Combustion of Cyanogen and the Burning Velocities of Cyanogen-Oxygen-Nitrogen Mixtures. E. Rutner, K. Scheller and W. H. McLain, Jr. *J. Phys. Chem. 64,* 1891 (1960) Dec. (6 pp.)

Burning velocities of cyanogen-air, and cyanogen-oxygen-nitrogen mixtures were measured by the tube and balloon methods. Results of these measurements were correlated with other investigators' thermal theories of flame propagation. In the application of the thermal theory it was found necessary to use a value of E = 39.9 kcal for the tube data, and 35.0 kcal for the balloon data. The observed variation of E can be related to the increase in the rate of reaction with an increase in O_2 concentration, and the subsequent closer correspondence of the actual flame temperature to the calculated one.

Flame Research

Gaseous Explosions in Vented Ducts. D. J. Rasbash and Z. W. Rogowski. *Combustion and Flame 4,* 301 (1960) Dec. (12 pp.)

Pentane and propane-air mixtures have been exploded in nine straight steel ducts with openings at one end. The size of the opening varied within the range K = 1 to 64 where K is the ratio of cross sectional area of the duct to the area of the opening. Pressure was recorded and with the longer ducts the progress of the flame also was recorded using ionization gaps. With the narrowest tube tested, higher pressures and flame speeds were obtained than with the other vented ducts although the tube gave a lower pressure with the unvented duct. With all ducts, flame speeds and pressures were very much smaller when ignition was near the vent. A relation is given for the rate of combustion in the ducts as a function of the Reynolds number in the unburnt gas and the pressures developed are discussed on the basis of the combustion rate in the ducts.

The Influence of Hydrogen or Deuterium on the Flame-Propagation Velocity of Carbon Monoxide and Air Mixtures. T. Scholte. *ZVDI 102,* 673 (1960) June (5 pp. German text.) [From *Appl. Mech. Rev. 13,* 933 (1960) Dec.]

Flame-propagation velocity of mixtures consisting of air and pure carbon monoxide does not depend on the concentration of the latter. By adding small quantities of hydrogen or deuterium the square of the flame-propagation velocity increases proportionately to the amount of agents added. Additions of hydrogen compounds also produce similar acceleration of the flame-propagation velocity. The results obtained provide an insight into the reaction mechanism and confirm that the diffusion of the radicals from the zone of flame into the unburned mixtures plays a more important role than heat conductance.

From author's summary

Kinetical Parameters in Premixed Laminar Flames. A. Van Tiggelen. AFOSR TN 59-1149 (Univ. Louvain, Lab. for Inorganic Chem. TN-2), 43 pp., (1960) Feb. [From *Appl. Mech. Rev. 13,* 933 (1960) Dec. (2 pp.)]

Burning velocities, obtained with methane-oxygen flames at different mixture ratios and different initial temperatures, are almost perfectly represented by a formula where the activation energy is 38 kcal and the reaction order with respect to oxygen is 1.4 and to methane −0.4. The formula corresponds exactly to the theory with a chain mechanism including a peroxide radical. From a kindred investigation performed on acetylene-oxygen mixtures a similar empirical formula is obtained. A chain reaction with the formation of a peroxide must also occur in these flames. Some experimental results with stoichiometric ternary methane-hydrogen-oxygen mixtures at different dilutions with nitrogen are also related.

From author's summary by H. Behrens, Germany

Structure and Propagation of Laminar Flames Near a Heat Sink. T. Chen and T. Toong. *Combustion and Flame 4,* 313 (1960) Dec. (11 pp.)

Paper presents results obtained in a theoretical investigation of the problem of laminar flame propagation near a heat sink. Results consist of two parts: 1) effects on the burning velocity of an adiabatic laminar flame due to a change in the temperature of the unburnt mixture; and 2) effects on the structure and the burning velocity of a laminar flame when the rate of heat loss per unit volume inside the flame in the direction normal to the mixture velocity and the rate of heat loss per unit area at the hot boundary in the direction parallel to the flow are prescribed by arbitrary functions. In all cases, the burning velocity is found to vary approximately with

the temperature of the combustion product at the hot boundary.

A Theory of Flame Extinction Limits. A. L. Berlad and C. H. Yang. *Combustion and Flame 4,* 325 (1960) Dec. (9 pp.)

Theory of flame extinction limits is formulated, which includes consideration of heat losses by conduction and radiation at every point of the temperature profile of the flame. The proper selection of boundary conditions is examined. In addition to the prescription of characteristic flame burning velocities (as in the adiabatic theory) this theory predicts flame extinction limits. Calculation of extinction limits are made for propane-oxygen-nitrogen flames.

The Theory of Flame Propagation in Branched and Unbranched Chain Systems. L. A. Lovachev. *Combustion and Flame 4,* 357 (1960) Dec. (11 pp.)

Approximate method for the solution of a set of energy conservation and active center diffusion equations, describing steady-state flame propagation by an unbranched one-center chain reaction, is proposed. Calculated values for burning velocities and the distribution of active centers as a function of temperature are in agreement with those obtained by numerical integration. An approximate solution for the problem of flame propagation in an unbranched chain system involving two active centers is given.

Gas Lights

Gas Runway Lights Prove Out in Year-Long Test. *Gas 37,* 70 (1961) Jan. (3 pp.)

Gas runway light has passed the test of a year's experience, and, in fact, is becoming a fixture on the aviation scene. In the last year, more than 500 gaslights have been installed or ordered for eight airports in Arkansas, Louisiana, Kansas and Canada. Article describes lights and discusses installation and operating costs.

Industrial Heating

Combined Town Gas/Fuel Oil Flames for Heating Ferrous Metals. E. A. K. Patrick and N. G. Patel. Gas Council Res. Comm. GC 67; *Gas Times 94,* 29 (1960) Dec.

Investigations carried out on the application of gas-oil burners to the heating of steel for forging are reported. The effect of types of fuel (i.e., fueloil, town gas, and various mixtures of fueloil and town gas) at differing excess air and times of heating on the quantity and adherence of scale formed on mild steel and alloy steels was studied. Decarburization of steel surfaces also has been considered.

New Pulsating Burner Saves Fuel and Operating Overhead. *Ind. Gas 39* (Amer.), 3 (1960) Dec. (2 pp.)

Use of a new type of pulsating gas burner in two 15,500-lb capacity aluminum reverberatory furnaces has brought about dramatic savings in both gas and operating overhead for one company. The burners use forced air at 3 psi and a special refractory liner to produce virtually perfect combustion of the natural gas used as fuel. Gas consumption at the company averages 1.3 CF/lb of aluminum melted.

Push-Button Machines Improve Brazing. J. Van Opynen. *Ind. Gas 39* (Amer.), 8 (1960) Dec. (2 pp.)

Stellite inserts attached to the leading edge of low-pressure turbine blades are used to prolong blade life. In the low-pressure section of the turbine, droplets of water are present and at the high linear blade speeds are highly erosive. Since they have been installed, the new automatic brazing machines have not only reduced brazing time for turbine blades by 60 per cent, but have substantially reduced cost and manpower requirements.

Why Gas Beats Oil in Reverberatory Iron Melting. S. J. Michaels. *Ind. Gas 39* (Amer.), 5 (1960) Dec. (3 pp.)

Case history presented relates that ductile iron casting was produced for a six-week period, using oil as the melting fuel, and then for a comparable period using gas as the melting fuel. The results of this trial period clearly indicated the superiority of natural gas from the standpoint of casting quality and economics. (Cast iron and ductile iron are exactly the same except for the shape of the graphite. A small amount of magnesium-bearing ferro silicon added to the ladle changes the graphite to a spheroidal shape—the main distinguishing characteristic of ductile iron.)

Ovens

High Speed Oven Design and Baking Studies. Part II. The Celeriter Oven. D. M. Spinell. *A.G.A. Lab. Res. Bull. 85,* (Proj. 1A-9) Nov. (1960) $2.00 (46 pp.)

High-speed baking and roasting was achieved in an experimental deck oven. This oven was specifically designed to improve heat transfer by forced convection and by utilizing an externally mounted duct furnace and blower to supply heated air to the baking compartment. With speed of cooking as the primary goal, conventional baking periods for a variety of products were reduced by as much as 50 per cent with no loss in food appearance and quality. Speed of roasting could also be accelerated with an acceptable product, but usually with increased weight losses. However, meats could be roasted in conventional times at reduced oven temperatures with less than normal weight losses.

How Gas Has Revolutionized the Canadian Baking Business. E. R. Tysoe. *Can. Gas J. 53,* 34 (1960) Nov. (3 pp.)

Today, three years from the date natural gas came to Vancouver, B.C., only four of the larger bakeries continue to use oil. Records indicate some 30 new gas services of which some are completely new bakeries, while some are new ovens replacing either coal or oil. There also were some 15 of the smaller-type deck or reel ovens converted with either flame burner, pipe or ribbon burners. Use of reel-type ovens has reduced the warming up period considerably, enabled more accurate heat control and more consistency of uniform products.

Refrigeration

Apparatus for Chilling Foodstuffs and the Like for Storage and Shipment. W. L. Morrison (assigned to Liquefreeze Co., Inc.) U.S. 2,959,034 (1960) Nov. 8.

In a food chilling apparatus, an improved heat exchange method is claimed. The insulated food compartment is chilled by a refrigerant (nitrogen) flowing through a pervious absorption pad. The evaporated gas from the refrigerant is bubbled in contact with the liquid refrigerant supply and further heat exchanged with the supply in its recycle to the liquefier.

Control for Refrigerating System. W. L. Morrison (assigned to Liquefreeze Co., Inc.) U.S. 2,957,318 (1960) Oct. 25.

In a food chilling unit operating on liquid nitrogen, an improved control of the liquid and gaseous nitrogen supply is claimed. The chilling stream and the evaporated gas are respectively passed to and from the multiple chilling stations by separate manifolds. The evaporated gas is heat exchanged and returned to the multiple-stage compressing liquefier. Excess nitrogen gas pressure from the food chiller, or lack of liquid nitrogen, actuates valves to permit recirculation of nitrogen at each compression stage or to permit increased expansion-liquefaction, respectively.

Space Heating

How to Apply High Intensity Infrared Heaters for Comfort Heating. *Heating, Piping & Air Conditioning 33,* 229 (1961) Jan. (16 pp.)

High intensity infrared heating units are being selected with increasing frequency for heating industrial plants and other large-volume heating applications. Many outdoor installations have also been made and these, too, are increasing both in quantity and variety. This method of heating is another useful tool for providing in-plant comfort and "relief" heating out-of-doors. It is not a panacea for heating problems and requires intelligent design and application as does any system. The high intensity units do not supplant ducted air systems or unit heaters in all applications. Article includes discussion on types of units available and applications.

Ventilation

Experiences with Branched-Flue and SE-Duct Systems for Venting Gas Appliances. W. J. Bennett, C. H. Purkis, J. B. Carne and T. T. White. Gas Council Res. Comm. GC 72; *Gas World 152,* 780 (1960) Nov. 26 (2 pp.); *Gas Times 94,* 32 (1960) Dec. (2 pp.)

Paper differs from its predecessors in that it is mainly concerned with the verification, in the field, or predictions and design data for shared flue systems established as a result of theoretical and laboratory work. Several installations in blocks of flats have been fully instrumented, and their behavior observed over a considerable period of time. Problems of instrumentation, air flow tests with models, appliance usage factors, and certain theoretical aspects also are discussed.

Gas Vent Tables. E. H. Perry. *A.G.A. Lab. Res. Rep. No. 1319,* (Proj. DA-5-HA) Dec. (1960) $1.00 (40 pp.)

Design tables and procedures are presented for single and multiple appliance gas vent systems. The main factors considered are vent and vent connector materials, vent connector configurations, size and height of vent pipe or chimney, and appliance rated input. Sample problems are solved to illustrate the methods of calculation for several types of vent systems.

A Study of Methods of Grease Removal from Commercial Kitchen Exhaust Air. W. L. Marn. *A.G.A. Lab. Res. Rep. 1323,* (Proj 1A-12) Dec. (1960) $1.00 (26 pp.)

Problems involved in the removal of grease from commercial kitchen ventilation air are presented. Without an effective method of grease vapor removal, grease particles collect in exhaust ducts and become a dangerous fire hazard as well as a frequent cleaning problem. Two filters and a commercial ventilator were studied as contemporary solutions to the problem. Although they removed a large amount of the grease, they did not appear to be a completely ideal solution. In attempting to develop a better means of grease removal by using gas-fired burners, studies of basic methods of incineration of grease from the exhaust air resulted in a prototype unit which accomplished 97.5 per cent grease removal at 200 CF/min exhaust air flow rate with a gas consumption of about 47,000 Btu/hr.

Suppression of Pulsations in Oil-Fired Residential Heating Equipment. C. F. Speich and A. A. Putnam. *ASHRAE J. 3,* 49 (1961) Jan. (8 pp.)

Previous, but yet unpublished, paper outlined a proposed mechanism for generation of pulsations in oil-fired heating equipment. The mechanism is complex and involves the proper phasing of an acoustic pressure oscillation and a periodic rate of heat release. Present paper is based on research results and discusses suppression techniques investigated in the program or described in the literature.

10. EQUIPMENT AND INSTRUMENTATION

Automation

Automation for the Operator. F. L. Friedli. *Gas 37,* 107 (1961) Jan. (3 pp.)

Automation, in various guises, has been in existence for over thirty years, says author. As in all progressive development, the operator has played a vital part in establishing the machinery or system to be controlled. Therefore, practically all design concepts today have evolved from the operators' creative ideas being translated by engineers into working hardware. Greatest single increase in automation has been more monitoring of operating machinery.

Computers 1: Applications in Industrial Research. M. W. Horrell. *Ind. Research 2,* 14 (1960-61) Dec.-Jan. (6 pp.)

Computer installations for research fall into two categories of use. In some applications a computer works in conjunction with other data-processing equipment. In others, a computer serves the engineer as a problem-solving mathematical tool. Article shows where

general-purpose computers in the small-to-medium-size range are being used and how major benefits can be derived.

Computers 2: Applications in Chemical Processing. A. W. Lemmon, Jr. and B. B. Gordon. *Ind. Research 2,* 20 (1960-61) Dec.-Jan. (6 pp.)

Steps that must be taken to make various chemical processes automatic are well known. Chemists and chemical engineers have used computers successfully for many more or less limited tasks. The real problem is combining scattered pieces of know-how into integrated systems that can perform efficiently enough to be economically advantageous. When automated chemical plants are achieved, the computer will be the "brain" to direct and watch over the processes, under human guidance. How such computers can be used and the areas in which they are likely to be useful are considered in the article.

Pipeline Built in 1929 Is Automated. *Petrol. Week 12,* 49 (1961) Jan. 13.

Mountain Fuel Supply Co. (Wyo.), disdaining the notion that it is uneconomical to automate an old pipeline, is bringing part of its 31-year-old gas transmission system under remote control. Project will bring seven of Mountain Fuel's stations under remote control at a cost of $75,000. Control headquarters will be at Rock Springs, Wyo., where data will be received on mainline pressure, differential pressure, and valve positions.

Pneumatic Controls. J. N. Novaly. *Instruments and Control Systems 33,* 2088 (1960) Dec. (2 pp.)

Author describes the basic mechanics of on-off, proportional, and integral control with pneumatic control devices.

Power Units for Plant Mechanization and Automation. Part 1. L. Walter. *Coke and Gas 22,* 535 (1960) Dec. (6 pp.)

Many operations in the coking and gas industries involve the repetition of mechanical movements of one kind or another. Ever-increasing range of work of this nature is being carried out during mechanical handling operations. This also applies to process in the byproducts industry, and control of plant equipment requires more automatic control action as process becomes more complex. As a medium of power for industrial power units, the choice is between compressed air, water or oil under pressure, or electricity. Use is governed by 1) availability, 2) cost, and 3) actual working conditions. Today, most designs of power units, whether pneumatic, hydraulic, or electric, are reliable, robust, powerful and easy to maintain.

Computers

Computer Design of Catalytic Reactors. R. M. DeBaun and S. F. Adler. *Chem. Eng. Progress 56,* 74 (1960) Dec. (3 pp.)

Manufacturer's viewpoint of the customer services demanded today in the selling of catalysts. Use of computers in calculating catalyst requirements is claimed to have reduced average problem cost from $300 to an amount that is less than $100.

Fluid Flow

To Move Air—Equations Find the Right Impeller. J. M. Watson. *Product Eng. 32,* 53 (1961) Jan. 9 (5 pp.)

After the specific speed needed has been calculated, it is easy to settle on the type of air impeller for a particular application. But making the final specific choice with only this information involves a long search of manufacturers' catalogs. However, most of the waste time can be eliminated if the required impeller size is known. Article describes method that can be used to find it.

Mathematical Methods

Mathematics of Control. T. J. Williams. *Chem. Eng. 68,* 103 (1961) Jan. 9 (8 pp.)

Application of mathematical and analytical tools to problems of process control raises an intuitive art to a quantitative science. Techniques outlined in article apply to distillation columns, reactors and to problems of optimization.

Piping

How to Design Yard Piping. R. Kern. *Petrol. Refiner 39,* 139 (1960) Dec. (10 pp.)

Minimum cost yard piping is a direct result of precise engineering design. Method described shows how to save piping dollars and gives a step-by-step evaluation procedure. Important sections are: how to 1) evaluate flow diagrams and other data, 2) analyze yard piping design, and 3) economize yard piping. Examples of yard piping design highlight all these factors and show details of the best yard piping at minimum cost.

Pipe Handling Apparatus. W. M. McConnell (assigned to Taylor-Wilson Mfg. Co.) U. S. 2,959,268 (1960) Nov. 8.

Pipe handling machine is claimed which manipulates the length of pipe onto a test bench and later removes it. Machine comprises two shafts transverse to the pipe length and the test station. These shafts rotate with a continuous helical rib, engage the pipe, and advance it to a bed where it is hydraulically tested. Notched heads lift the pipe from the bed and move it forward after testing.

Thin-Wall Pipe for Oil and Gas Lines. W. P. Heineman. *Pipe Line News 32,* 41 (1960) Dec. (6 pp.)

Thin-wall line pipe has found a definite place in the oil and gas industry. The selection of the desired thickness for the higher stress level service needs consideration of the many factors discussed. It is not recommended that the thinner walls be operated at stress levels as high as the thicker walls but, if a 50 per cent maximum stress level was imposed on walls 3/16-in. or less, the savings in steel are still great and worth consideration. Advantage should be taken of the higher strength materials since they permit operation at lower stress levels with the same internal pressure.

Valves

Operating and Maintaining Pressure Controlling Devices. W. A. Urban, Jr. *Gas Age 126,* 24 (1960) Dec. 8 (4 pp.)

In a discussion of operation and maintenance of pressure controlling devices, author provides a guide to practices and procedures. His presentation is based upon practices adapted and put into effect by his company from generally accepted industry and manufacturer recommendations. Devices discussed are plug and gate valves, regulators, relief or safety shut-off valves in service at gate stations, regulator houses or vaults, valve pits and large commercial or industrial metering sites.

11. MATERIALS OF CONSTRUCTION, AND CORROSION

Cathodic Protection

Combined Cathodic Protection and Cleaning for Heat Exchangers. M. J. Olive. *Corrosion 17,* 9 (1961) Jan. (3 pp.)

Use of cathodic protection and cathodic cleaning of heat exchange equipment are described. Explains how cathodic protection system was used to supplement water treatment. Data given show 20 condensers were protected by anodes at $800/yr. Cleaning and repair costs for the condensers had been $2000/yr—a saving of $1200 in labor costs alone. Also, article shows that cathodic cleaning of boilers costs only $60/boiler. Estimated chemical cleaning cost per boiler was $1500—a saving of $1440/boiler.

Methods and Experience in Underground Cathodic Protection. Part 2. Bare Steel Pipe Lines. L. H. West. *Corrosion 17,* 46t (1961) Jan. (3 pp.)

Discussion is given of survey methods used for the detection of galvanic "hot spots" along bare steel pipelines, correlation of these data with actual failures, and galvanic anode installation. Results of the survey correlated well with corrosion leak experience and with visual inspection of the pipelines. Two case histories are reported.

Methods and Experience in Underground Cathodic Protection. Part 3. Gas Transmission and Distribution Lines. P. P. Skule. *Corrosion 17,* 48t (1961) Jan. (2 pp.)

General coverage is made of cathodically protecting gas services, distribution transmission, and storage lines for new and existing older lines. Benefits and weaknesses in protection methods are discussed. Early day protection of lines is contrasted with present methods.

Pipeline Cathodic Protection Economics. F. A. Therrell, Jr. *Corrosion 17,* 12 (1961) Jan. (2 pp.)

Corrosion cost and cost of corrosion control are estimated from one company's experience. Figures are given on case histories to show corrosion cost, estimated cost of metal loss on pipe, estimated cost of cathodic protection and comparison between costs of protecting bare and coated pipe. Article also discusses savings that can be realized through cathodic protection, and compares installation and operation costs of conventional and deep groundbed facilities.

Unusual Problems Encountered in Cathodic Protection of Miami Seaquarium. E. J. Tilton, Jr. *Corrosion 17,* 16 (1961) Jan. (2 pp.)

Unusual problems are described in designing and installing a cathodic protection system for two steel tanks. Problems involved working under water because tanks could not be drained and because of damage to anodes and their leads by large fish and sea turtles. Vertically hung anodes were not suitable because they would interfere with porpoises. Descriptions of anodes, conduits and volume of impressed current are given.

Corrosion

Corrosion Studies of Aluminum in Chemical Process Operations. E. H. Cook, Jr., R. L. Horst and W. W. Binger. *Corrosion 17,* 25t (1961) Jan. (6 pp.)

Several developments are presented which describe the evolution of laboratory studies into commercial applications for aluminum alloys in the chemical and petroleum industries. Particular attention is given to the study of aluminum alloys for handling 83 per cent ammonium nitrate solutions at elevated temperature. Based on laboratory results, operating procedures have been established for the storage and handling of 83 per cent ammonium nitrate. The discussion also includes applications of aluminum in the production and handling of aliphatic acids, sour crude oil, amines, hydrogen peroxide, fuming nitric acid, liquids at cryogenic temperatures and high purity water.

Design for Prevention of Pipe Line Corrosion Based on Survey of Ground Potential Distribution. S. Fukuta, S. Kondo, N. Usami and S. Sekimoto. *Corrosion 17,* 50t (1961) Jan. (3 pp.)

Report of a procedure adopted in designing the cathodic protection system and other corrosion control provisions for a pipeline. The steps taken were: 1) pipeline route was determined; 2) ground potentials along the route with reference to a fixed sufficiently remote ground potential were measured with recording instruments, and ground potential distribution profile of the route was obtained; 3) pipe-to-ground potential distribution along the route was anticipated according to the previously cited ground potential distribution profile; 4) specifications for the pipe protective coating and covering locations of cathodic protection or drainage equipments and their current ratings were determined; 5) pipes and other necessary materials were prepared and installed; and 6) after the pipeline construction work was completed, the pipe-to-ground potential distribution profile was obtained to check the adequacy of the design.

Factors Influencing Electrical Soil Resistance and Its Importance for Corrosion Protection. W. Baeckmann. *Gas- und Wasserfach 101,* 1265 (1960) Dec. 2 (9 pp. German text.)

Determination of electrical soil resistance helps to define conduction paths in the search for aggressive regions in

already installed piping and in the establishment of installation locations. Through year-long moisture and temperature variations, great changes are produced in the apparent specific soil resistance, which is dependent on soil type, structure and bedding. To clarify this question, the DVGW Technical Committee on Corrosion Problems of Pipe Networks conducted a broad research program. Topics investigated include soil resistance measurements, soil type, structure, electrolytic content, moisture and temperature. Results are discussed on the basis of importance and practical application.

There Are Still Ways to Combat High Corrosion-Control Costs. T. J. J. Degnan and N. K. Senatoroff. *Oil Gas J. 59,* 72 (1961) Jan. 9 (5 pp.)

Cost reduction implies a proper balance of initial and all future costs. The former includes cost of pipe, coating, and cathodic protection. These items are more readily estimates and are generally given undue weight. Future costs include maintenance, repair and operation. The steady rise in prices, particularly labor and equipment, multiplies the importance of elements which must be paid for with tomorrow's dollars. Cost reduction does not rule out considerations of quality and it must be based on three steps: thorough planning, careful construction, and continuous monitoring of operation. These steps may be studied in an examination of: 1) control of environment; 2) cathodic protection; and 3) pipe coating.

Plastics

Accelerated Test Procedure for Evaluation of Fiber Reinforced Resin Equipment in the Chemical Industry. R. A. Cass and O. H. Fenner. *Corrosion 17,* 1t (1961) Jan. (7 pp.)

Account is given of the testing and evaluation procedures followed by a major chemical company in the selection of plastics for severe service. The use of the Instron Tensile Tester to furnish necessary physical properties change data, as a supplement to weight change data, is described. Various applications of plastic materials of construction under unusual or borderline environments are reviewed. Extensive data are reported on glass fiber reinforced epoxy resins percentage weight change vs flexual strengths with various plasticizers, and of glass fiber reinforced polyester resins percentage weight change vs flexural strength after exposure in such media as salicyclic acid-sulfuric acid-water, 28 per cent HCl, and maleic acid.

Refractories

Further Observations on the Behaviour of Refractories in Oil-Gas Plants. L. Sabiston. [From 51st Report of the Joint Refractories Research Committee: 1959-60. Gas Council Res. Comm. GC 71, 14 (1960) Nov. (7 pp.)] *Gas World 152,* 785 (1960) Nov. 26 (2 pp.)

Brief descriptions of the three main types of oil-gas plants in use in Great Britain together with reports of the most frequently encountered sources of refractory failure were contained in the 49th Report. During the interval, more information has been accumulated as a result of visits to plants and reports sent in by engineers. Current report brings earlier one up-to-date.

Insulating Firebrick for Periodic Kilns. R. C. Shehane and P. R. McClafferty. *Am. Ceramic Soc. Bull. 39,* 721 (1960) Dec. (6 pp.)

Article presents an up-to-date analysis of the increased use of insulating firebrick in the structural clay products industry, and a discussion of reduced construction and operating costs in periodic kilns through the use of insulating firebrick. An appraisal of insulating firebrick as applied to periodic kilns used in the manufacture of salt-glazed sewer pipe is included.

12. ANALYTICAL METHODS AND TESTS

Air Pollution

Continuous Parts per Billion Recorder for Air Contaminants. J. P. Strange, K. E. Ball and D. O. Barnes. *J. Air Pollution Control Assoc. 10,* 423 (1960) Dec. (4 pp.)

High sensitivity, continuous recording, and instantaneous response for a large number of noxious or toxic air contaminants can be obtained by a unique combination of chemical and physical detection principles. Sensitivities in the range of parts per million (ppm) are usually obtained with ease. For many compounds, a full-scale range for less than 100 ppb is quite feasible. The method is not completely specific, although enhancement of the response to one compound in a mixture can usually be attained. Each application should be studied carefully to take advantage of all discriminating techniques and summation of coexisting toxic contaminants when practical from the viewpoint of hazard.

A Miniature Electrostatic Precipitator for Sampling Aerosols. Theory and Operation. M. Robinson. *Anal. Chem. 33,* 109 (1961) Jan. (5 pp.)

Particulate matter in gases, such as aerosols, is determined by an electrostatic precipitation technique. A miniature electrostatic precipitator is developed and equations given to validate its effectiveness. The method assumes monodisperse spherical particles and is therefore subject to this limitation.

Chromatography

Adsorption Phenomena and Their Effects on Analytical Accuracy in Gas Chromatography. A. Weinstein. *Anal. Chem. 33,* 18 (1961) Jan. (5 pp.)

Effect of an adsorbed carrier on analytical accuracy in gas chromatography is investigated. Peaks of shortest retention time are the most affected. Evidence is given as to how the error arises and how it may be avoided or minimized.

Gas Chromatographic Analysis of Incinerator Effluents. W. N. Tuttle and M. Feldstein. *J. Air Pollution Control Assoc. 10,* 427 (1960) Dec. (4 pp.)

Procedure for the gas chromatographic analysis of incinerator effluents described has been used to analyze the effluents from a series of incinerators. Results indicate that, when the concentration of C_2 hydrocarbons is below 10 ppm, the C_3 to C_6 hydrocarbons are generally present in less than 1-2 ppm. When the C_2 hydrocarbons are present in high concentrations, the C_4 to C_6 compounds are generally present in significant concentrations. Some specific C_4 to C_6 compounds found in the effluents from incinerators have been identified.

Gas Chromatography. The Effect of Gaseous Diffusion on Mass Transfer in Packed Columns. R. Kieselbach. *Anal. Chem. 33,* 23 (1961) Jan. (6 pp.)

Experimental evidence clearly indicates the importance of the effect of gaseous diffusion on mass transfer in gas chromatography columns. Further evidence clarifies the confusion regarding the effects of liquid concentration and gas diffusivity on high performance columns. A more complete equation for H.E.T.P. would permit the systematic design of columns with greater precision.

Coal

A Study of Coal by Mass Spectrometry II—Extracts and Extractable Pyrolysis Products. H. W. Holden and J. C. Robb. *Fuel 39,* 485 (1960) Nov. (10 pp.)

Examination of the potentialities of mass spectrometry for research in coal constitution and pyrolysis indicates a number of promising possibilities with suitably prepared samples. Spectra of some coals and coal extracts have yielded information about the aliphatic content and reactivity of extractable constituents.

The Ultra-violet Spectra of Coal-like Materials. R. Bent and W. R. Lander. *Fuel 39,* 479 (1960) Nov. (6 pp.)

Ultraviolet spectra of the products of low-temperature carbonization below 450°C in high vacuum have been studied in chloroform solution in the region 2500-5000 A. The solutions which obey Beer's law show a broad maximum in their absorption at about 2650 A. The level of absorption is compared with that found for pure aromatic substances and shows that these products could in fact contain a fairly high proportion of complex aromatic material.

Dust Determination

Automatic Techniques for Airborne Particle Counting. A. Lieberman and J. Stockham. *Air Eng. 2,* 40 (1960) Dec. (3 pp.)

Article presents quantitive data on particle size and concentration in an ultraclean room under simulated operations conditions. These data were obtained with an automatic particle counter and size discriminator, which has some interesting applications for monitoring clean rooms. It immediately provides data on the dust level in the most useful form—particle diameter and concentration. The instrument not only makes it possible to study particle size and concentration, but also to determine their effects on instrument reliability.

Mercaptans

Determination of Mercaptans by Titration with Mercury (II). J. S. Fritz and T. A. Palmer. *Anal. Chem. 33,* 98 (1961) Jan. (3 pp.)

Titrimetric procedure using mercury (II) perchlorate as titrant is employed for the rapid determination of mercaptans. The end point is detected visually or potentiometrically using thio-Michler's ketone indicator or a mercury indicator electrode. Sulfur, sulfide, iodide, cyanide, and thiocarbonyl compounds interfere.

Solubility

The Use of Tritium to Study the Solubility of Water in Hydrocarbon Liquids. B. D. Caddock and P. L. Davies. *J. Inst. Petrol. 46,* 391 (1960) Dec. (6 pp.)

Experimental apparatus and technique are described in detail, and results are given for two hydrocarbon liquids, namely, benzene and toluene. The systems are shown to obey Henry's Law up to saturation and the total solubilities obtained at 20°C are 52 and 46 mg/100g, respectively. These values agree well with other published data. The isotope effect in the evaporation of a solution of the tritiated water to saturate an air stream at constant temperature also has been measured. The radioactivity of the vapor is shown to be 13 (±2) per cent lower than that of the solution in the range of temperatures (5°-20°C) studied.

Sulfur

Determination of Sulfur in Gasoline in X-Ray Emission Spectrography. R. A. Jones. *Anal. Chem. 33,* 71 (1961) Jan. (4 pp.)

Sulfur content of gasoline is determined using X-ray emission spectrography. The method requires no prior knowledge of the sample since the addition technique compensates completely for variations between sample matrices. A determination is accomplised in 15 to 25 minutes.

X-Ray Techniques

Quantitative Determination of Low Atomic Number Elements Using Intensity Ratio of Coherent to Incoherent Scattering of X-Rays. Determination of Hydrogen and Carbon. C. W. Dwiggins, Jr. *Anal. Chem. 33,* 67 (1961) Jan. (4 pp.)

Low atomic number elements, such as carbon and hydrogen, are determined quantitatively by a new, accurate X-ray technique. The method is based on the intensity ratio of coherent to incoherent scattering of X-rays. Multiple analyses of carbon and hydrogen in hydrocarbons are made within 20 minutes.

13. BASIC SCIENCE

Carbon Monoxide

Potential Energy Curves for CO. I. Tobias, R. J. Fallon and J. T. Vanderslice. *J. Chem. Phys. 33,* 1638 (1960) Dec. (3 pp.)

Potential energy curves for several electronic states of the CO molecule have been calculated by the Rydberg-Klein-Rees method. The curve for the $A^1\pi$ state will have to blend sharply in the range between 1.9 and 2.1 A or it will have to pass through a maximum to reach the proper dissociation limit.

Fluid Flow

Characteristics of the Mean Flow Patterns and Structure of Turbulence in Spiral Gas Streams. W. R. Schowalter and H. F. Johnstone. *A.I.ChE. J. 6,* 648 (1960) Dec. (7 pp.)

Measurements were obtained of the flow structures in two types of spiral flow fields. The first was a vortex tube in which air entered one end of an 8-in. pipe through an involute entry and left at the opposite end. The second was a conventional cyclone separator in which the same entry was used. The experimental results show that the mean and turbulent flow structures are not sensitive to changes in the flow rate, but that they are greatly affected by the geometry of the system.

Effects of Solids on Turbulence in a Fluid. H. Kada and T. J. Hanratty. *A.I.Ch.E. J. 6,* 624 (1960) Dec. (7 pp.)

Effect of solid particles on fluid turbulence was studied for fully developed flows of slurries in a vertical 3-in. pipe for solids concentrations ranging from 0.13 to 2.5 volume %. Point source turbulent diffusion data in the slurry flows were compared with data for flows without solids present. The solids do not appear to have a large effect on the diffusion rate unless there is an appreciable average slip velocity between the solids and the fluid and unless the solids concentration is high enough.

Flow Measurement Errors. S. T. Bonnington and K. J. Zanker. *Chem. & Process Eng. 41,* 537 (1960) Dec. (4 pp.)

Research on pressure-differential methods, used in the measurement of fluid flow, is being carried out in many laboratories and is leading to a better understanding of the factors affecting accuracy. Article presents a survey of published information on the causes and magnitude of flow measurement errors for pressure-differential meters and describes the results of experiments carried out at the British Hydromechanics Research Association to develop a flow-straightening device which will enable the use of shorter lengths of approach piping.

Heat Transfer

Heat Transfer in Solids-Gas Transport Lines. C. Wen and E. N. Miller. *Ind. Eng. Chem. 53,* 51 (1961) Jan. (3 pp.)

Proposed heat transfer correlation for solids-gas transport line and dilute-phase fluidized bed is presented. The mechanism of heat transfer for solids-gas systems is considered. Unlike dense-phase fluidized bed, solids concentration rather than solids velocity offers a significant effect on heat transfer. The resulting correlation includes all available horizontal and vertical transport data. The effect of system parameters on heat transfer coefficients is considered; applicability and limits of the correlation are ascertained.

A Theoretical Analysis of Laminar Natural Convection Heat Transfer to Non-Newtonian Fluids. A. Acrivos. *A.I.Ch.E. J. 6,* 584 (1960) Dec. (7 pp.)

Equation is given for the local Nusselt number in laminar convection heat transfer to power-law non-Newtonian fluids. This expression, which even for Newtonian fluids ($n = 1$) does not appear to have been derived before, is obtained from the exact asymptotic solution of the appropriate laminar boundary layer equations and is applicable to any two-dimensional surface or a surface of revolution about an axis of symmetry when, as is usually the case, $N_{Pr} > 10$.

Hydrates

A Study of Hydrates in the Methane-Propylene-Water System. F. D. Otto and D. B. Robinson. *A.I.Ch.E. J. 6,* 602 (1960) Dec. (4 pp.)

Experimental data are presented to show the points of incipient hydrate formation in the methane-propylene-water system. The locus of the four-phase equilibrium consisting of hydrate, vapor, water-rich liquid, and hydrocarbon-rich liquid was determined. Solid-vapor equilibrium ratios were estimated for propylene hydrates. The significant features of the phase diagrams for the system are discussed in some detail.

Hydrocarbons

The Critical Temperatures and Pressures of Binary Systems: Hydrocarbons of All Types and Hydogen. R. B. Grieves and G. Thodos. *A.I.Ch.E. J. 6,* 561 (1960) Dec. (6 pp.)

Method of the prediction of the critical temperatures and pressures of mixtures has been developed, primarily on the basis of data for binary hydrocarbon systems available in the literature. These mixtures may contain aliphatic (normal paraffinic, isoparaffinic, and olefinic) naphthenic, and aromatic hydrocarbons as well as hydrogen. The mixtures may be of varying complexity. Study introduces two dimensionless temperature parameters, γ and θ, which account for the composition of the mixture and for the nature of the components involved.

Vapor Pressures: Unsaturated Aliphatic Hydrocarbons. C. H. Smith and G. Thodos. *A.I.ChE. J. 6,* 569 (1960) Dec. (6 pp.)

Vapor pressure data available in the literature for olefins, diolefins and acetylenes have been used to establish the constants of the Frost-Kalkwarf equation. This equation requires the establishment of constants A, B, C, and D and defines accurately the vapor pressure function over the complete range included between the triple point and the critical point. Constant D has been shown to be equal to $a/2.303R^2$. Both van der Waals' constants can be predicted from the molecular structure, thus enabling the calculation of the critical temperatures and pressures for those unsaturated hydrocarbons. Constant B has also been found to depend on the molecular structure of these hydrocarbons. The normal boil-

ing point of an aliphatic hydrocarbon in conjunction with its critical point and the values B and D calculated from structural considerations permit the calculation of constants A and C. All four vapor pressure constants were calculated for 27 monoolefins, 9 diolefins, and 5 acetylenes.

Kinetics

Calculation of Reactor Volume from Laboratory Kinetic Data. R. F. Strickland-Constable. *Chem. & Ind.*, 1514 (1960) Dec. 10 (6 pp.)

Designer is not in principle required to know anything at all about the theories of kinetics or the molecular mechanism of reactions. Provided the appropriate rate equation has been determined in the laboratory all that the designer has to know is the purely mathematical procedure needed to deduce this from the required reactor volume. Article discusses this procedure entirely divorced from any consideration of the mechanism of the reactions or the theories of chemical kinetics. The procedure may also be of use to the research chemist who wishes to analyze the kinetics of reactions in flow reactors.

Process Kinetics Can Predict Reaction Mechanism. H. Eyring. *Chem. Eng. 67,* 83 (1960) Dec. 26 (5 pp.)

Analysis of the molecular structure of reactants by the reaction rate theory makes it possible to predict the rate determining steps for elementary reactions, accommodation coefficients, thermal conductivity in liquids, liquid structure, liquid viscosity, diffusion coefficients, strain electometry or ion smelting.

Thermal Conductivity

Thermal Conductivity: Reduced State Correlation for Ethylene and Its Application to Gaseous Aliphatic Hydrocarbons and Their Derivatives at Moderate Pressures. E. J. Owens and G. Thodos. *A.I.Ch.E. J. 6,* 676 (1960) Dec. (6 pp.)

By means of a procedure similar to that used for the inert gases and methane, a reduced thermal conductivity correlation was developed for ethylene from experimental data available in the literature. The resulting correlation permits the prediction of thermal conductivities for gaseous and liquid ethylene in the temperature range $T_R = 0.4$ to $T_R = 6.0$, and for pressures up to $P_R = 50$. Experimental thermal conductivities of ethylene in the liquid state and dense-phase region were compared with values predicted by the reduced-state correlation. The average deviation for 36 experimental points was 1.8%.

Viscosity

An Experimentally Verified Theoretical Study of the Falling Cylinder Viscometer. J. Lohrenz, G. W. Swift, and F. Kurata. *A.I.Ch.E. J. 6,* 547 (1960) Dec. (4 pp.)

Theoretical analysis was conducted for laminar fluid flow in the annulus of a falling cylinder viscometer. A viscometer calibration constant was defined from the results of this analysis. This constant was expressed in terms of only the physical dimensions of the viscometer. The validity of the theory was demonstrated by the agreement between predicted and experimental values of the viscometer constant.

Water

Spraying Phenomena in the Cooling Tower. W. Otte. *Brennstoff-Warme-Kraft 10,* 371 (1958) Aug. (3 pp. German text.) [From *Appl. Mech. Rev. 13,* 932 (1960) Dec.]

Purpose of article is to describe how entering warm water can be distributed evenly over the surface area of the cooler. There is a heat exchange between the water drops in the spray and the air leaving the cooling tower, the amount of which depends on the number, size, and distribution of the droplets. Author discusses the trajectory of the spray, effect of updraft of air, design measures for producing small droplets ,and the arrangement of spraying outlets in the tower.

K. J. DeJuhasz, USA

Experiments with Spraying Nozzles. W. Otte. *Brennstoff-Warme-Kraft 12,* 217 (1960) May (2 pp. German text.) [From *Appl. Mech. Rev. 13,* 932 (1960) Dec.]

Continuation of preceding article. Using a nozzle of 26-mm diam and a water discharge rate of 10.1 cu m (2700 gal/hr), several types of distribution plates were used, with different diameter, depths, and numbers of serration. The results were compared in regard to evenness of coverage of the sprayed area.

K. J. DeJuhasz, USA

Services Available to GAS ABSTRACTS Readers

Photocopies

Photocopies of all articles abstracted in *Gas Abstracts,* except those enumerated here, are available from the Institute at cost:*

1) Russian Articles.—Abstracts are obtained from services specializing in this field. English translations can be supplied by arrangement with the appropriate abstractor.
2) U.S. Patents.—Printed copies can be secured at 25 cents each (remittance with order) from the Commissioner of Patents, Washington 25, D.C.
3) Books, Special Reports.—When a price is given in the abstract, these should be secured from a bookdealer or the publisher; when stated *free,* from the publisher.

Types of Photocopies

Depending on the "tightness" of the binding (which determines whether pages can be laid flat without breaking the binding), and the color of the paper and ink used in the original being copied, photocopies may take any of several forms:

1. Positive paper prints made by the reflex process.
2. Positive paper prints enlarged by xerography from microfilm negatives.
3. Negative photostats.
4. Positive photostats.

Choice of the method used must necessarily rest with the Institute. All photocopies are approximately the same size as the original material.

Cost of Service

The photocopy service charge is:

First 5 pages or fraction thereof of one article in one issue $1.50

Each subsequent 4 pages or fraction thereof of the above one article in the same issue..... $1.00

Invoices are rendered to the Institute's Members and Contributors only; payment in advance is required of others.

The Institute may, at its option, fill orders from non-Members and non-Contributors without payment in advance, but an additional charge of $1.00 to cover billing costs will be made on each such order.

Microfilm

Microfilm copies of articles abstracted in *Gas Abstracts* are likewise available at cost.* The material is photographed on 35 mm unperforated negative film at 5¢ per page, with a minimum of 50 pages, $2.50, per order. Invoices are rendered to the Institute's Members and Contributors only; payment in advance is required of others.

The Institute may, at its option, fill orders from non-Members and non-Contributors without payment in advance, but an additional charge of $1.00 to cover billing costs will be made on each such order.

Bibliographies and Literature Searches

The library will prepare bibliographies and make literature searches on a cost basis plus a service charge. A comprehensive statement detailing the problem must be presented with the request.

Gas Abstracts on Cards

The abstracts in each monthly issue are also printed individually on 5 x 8-inch cards. Each card bears at its top the author and subject headings under which it may be filed. As many copies of each card are supplied as there are headings on that card, enabling filing of the abstract under all of its headings, eliminating cross-indexing.

The annual subscription to *Gas Abstracts on Cards,* a mailing of 500-1000 cards each month, is $120.00 to U. S. addresses, $150.00 foreign.

Since the printing order for cards is based on the current number of subscribers, a subscription for this service commences with the month in which the order is received. Back numbers of *Gas Abstracts on Cards* are not available.

Back Numbers of Gas Abstracts

In response to an increasing number of requests from utilities, colleges, and technical libraries which have only recently learned of the reference value of *Gas Abstracts,* the Institute has taken steps to make available single numbers, volumes, or complete files of this publication to date, starting with Vols. 1 (1945) and 2 (1946), some numbers of which are out of print.

The latter numbers are reproduced by a photoprinting process from copies in the Institute's libraries, and Vols. 1 and 2 can now be purchased at $35 per volume, unbound; single monthly numbers are offered at $3 each.

Vols. 3 to date are available at current subscription prices, $18 per volume to U. S. addresses, $22 foreign. Monthly numbers are $2 each.

---

*In requesting and accepting photocopies or microfilm copies, the applicant agrees to the following:

1. The applicant desires this duplication solely for use in lieu of loan or manual transcription. Responsibility for questions of copyright that might arise in this copying, and in the use of the copies, is assumed by the applicant.

2. The applicant understands that the Institute does not sell the photocopies, but merely performs the service of copying at the applicant's request; the fee paid is exclusively for such service and is established on the basis of no profit to the Institute.

3. The Institute reserves the right at its own discretion to decline to make photocopies requested, or to limit the number of copies, within the principle of fair use of copyrighted material.

Publications Abstracted for GAS ABSTRACTS

Air Conditioning, Heating and Ventilating
Air Engineering
Air Pollution Control Association, Journal of
American Chemical Society, Journal of
American Gas Association Monthly
American Gas Journal
American Institute of Chemical Engineers, Journal of
American Society for Testing Materials Bulletin
American Society of Mechanical Engineers, Transactions of
Engineering for Power, Journal of (Series A)
Engineering for Industry, Journal of (Series B)
Heat Transfer, Journal of (Series C)
Basic Engineering, Journal of (Series D)
Applied Mechanics, Journal of (Series E)
Analytical Chemistry
Appliance Manufacturer
Applied Chemistry, Journal of
Applied Mechanics Reviews
Applied Physics, Journal of
Applied Spectroscopy
ARS Journal
ASHRAE J.
Australian Journal of Applied Science
Australian Journal of Chemistry
Battelle Technical Review
Bituminous Coal Research
Brennstoff-Chemie (German)
British Coal Utilization Research Association Monthly Bulletin and *Quarterly Gazette*
Business Week
Butane-Propane News
California Oil World
Canadian Chemical Processing
Canadian Gas Journal
Canadian Journal of Chemical Engineering
Canadian Journal of Chemistry
Canadian Journal of Physics
Ceramics (British)
Chemical and Engineering Data, Journal of
Chemical and Engineering News
Chemical & Process Engineering
Chemical Education, Journal of
Chemical Engineering
Chemical Engineering Progress
Chemical Physics, Journal of
Chemical Processing
Chemical Reviews
Chemical Society, Journal of (British)
Chemical Society, Proceedings (British)
Chemical Week
Coal Heat
Chemistry & Industry (British)
Coal Utilization
Coke and Gas (British)
College Placement, Journal of
Combustion
Combustion and Flame (British)
Communications of the ACM
Compressed Air
Computers and Automation
Construction Methods and Equipment
Control Engineering
Corrosion
Corrosion Technology (British)
Cost Engineering
Datamation
Design News
Drilling
Electronics
Engineers' Digest (British)
Erdöl und Kohle (German)
Faraday Society, Transactions of (British)
Fuel (British)
Fuel Efficiency (British)
Fueloil & Oil Heat
Gas
Gas Age
Gas & Oil Power (British)
Gas Council Research Communications (British)
Gas Heat and Comfort Cooling
Gas Industries
Gas Journal (British)
Gas Service and Domestic Coke
Gas Times (British)
Gas- und Wasserfach (German)
Gas World (British)
Gazovaya Promyshlennost (Russian)
Heating, Piping & Air Conditioning
Independent Petroleum Association of America Monthly
Industrial and Engineering Chemistry
Industrial Finishing (British)
Industrial Gas (American)
Industrial Gas (British)
Industrial Heating
Industrial Research
Industries du Gaz, Journal des (French)
Institute of Fuel, Journal of (British)
Institute of Gas Technology Research Bulletins
Institute of Petroleum, Journal of (British)
Institution of Gas Engineers Bulletins and *Communications* (British)
Instrumentation
Instruments and Control Systems
Izvestiva Akademii Nauk S. S. S. R. Otdelenie Khimicheskikh Nauk (Russian)
Khimiya i Tekhnologiya Topliva i Masel (Russian)
LP-Gas
Lubrication
Lubrication Engineer
Mathematical Aids to Computation
Mechanical Engineering
Metals, Journal of
National Aeronautics and Space Administration Memorandum
National Fire Protection Association Quarterly
National Gas Bulletin of Australia
National Petroleum News
Nuclear Science and Engineering
Nucleonics
Oil and Gas Journal
Optical Society of America, Journal of
Organic Chemistry, Journal of
Petro/Chem Engineer
Petroleum (British)
Petroleum Engineer, The (Drilling and Producing)
Petroleum Engineer, The (for Management)
Petroleum Refiner
Petroleum Technology Journal of
Petroleum Week
Physical Chemistry, Journal of
Physics and Chemistry of Solids (British)
Physics of Fluids (British)
Physics Today
Pipeline Engineer
Pipe Line Industry
Pipeline News
Power
Producers Monthly
Product Engineering
Progress (Pakistan)
Public Utilities Fortnightly
Research/Development
Research, Journal of, A. Physics and Chemistry
Research, Journal of, B. Mathematics and Mathematical Physics
Research, Journal of, C. Engineering and Instrumentation
Review of Scientific Instruments
Revue Generale du Gaz (Belgian)
Rivista dei Combustibili (Italian)
Science
Scientific & Industrial Research, Journal of, A. General (India)
Scientific & Industrial Research, Journal of, B. Physical Sciences (India)
Scientific Instruments, Journal of (British)
Solid-State Electronics
Stroitel'stvo Truboprovodov (Russian)
Svenska Gasverksföreningens Månadsblad (Swedish)
Technical News Bulletin
U.S. Bureau of Mines Bulletins, Information Circulars and Reports of Investigations
U.S. Patents
Uspekhi Khimii (Russian)
World Oil
World Petroleum